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SCIENCE IN POLITICS.

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THE most noteworthy feature of our modern civilization, and the one which distinguishes it from all the civilizations of the past, is its growing dependence upon scientific methods. This is manifested in every department of life, and in every line of thought; it is evident in all arts and industries; and in a multitude of ways it affects government. As modes of living change, the statutory regulation of affairs changes also; as the public thought broadens, methods of administration become broader; as science multiplies the resources of mankind, and brings the nations closer together, legislation recognizes the new condition of the world, and enters upon fields undreamed of a century ago. To-day, every civilized government invokes the aid of science to protect it from enemies, to increase public wealth, and to solve great economic problems; and both science and the state necessarily react upon each other.

The moment we examine closely our own national administration, we find an amazing development in certain lines of scientific industry. Nearly every executive department either has scientific experts regularly connected with it, or employs such experts occasionally for the conduct of important investigations. The work they do is not only "practical," as seen from the most utilitarian point of view, it is also broadly scientific in the highest sense of the term; and it represents in the clearest way the growth of the national intelligence. Some of the investigations relate to the perfecting of national defenses; some to obtaining a better knowledge of the national domain; some to the protection of men and animals against pestilence; and others to the prevention or exposure of certain kinds of fraud. A bare list of the

scientific questions with which an intelligent government has to deal would almost fill a volume; for present purposes, the merest summary must suffice.

Beginning with the defensive branches of our public service, we find that both the army and navy have much to demand of science. At West Point and Annapolis, at public expense, the cadets are taught the elements of science; and these elements, with certain limitations, are afterward professionally applied. In the Ordnance Corps, at the Torpedo Station, etc., men of science are actively engaged upon problems which involve both applications of known facts and explorations into the unknown; and upon the results of their experiments and studies the safety of the nation may depend. The army engineers have to deal with many other scientific questions, such as relate to the building of fortifications, the strength of materials, and so forth; and during times of peace they have also charge of river and harbor improvements throughout the land. These improvements, as at Hell Gate or along the Mississippi, involve applications of rigidly scientific methods, and require familiarity with the latest instrumental improvements. Allied to this work is that of the Hydrographic Office, which perfects the knowledge of our harbors; thus aiding navigation, and at the same time furnishing data which may be available for purposes of defense. The army and navy both maintain strong medical corps; and here, apart from the mere treatment of wounds or diseases, much useful work relating to medical science is done. The nature of an epidemic is investigated, the water-supply of a fort examined, the sanitary condition of a ship regulated, medical statistics accumulated, and so on. In the navy, compasses have to be studied with reference to the magnetic character of their surroundings on shipboard; and an observatory, famous among the observatories of the world, is maintained. Here are found the data necessary for navigation, standard time is furnished, chronometers are rated, and the highest investigations in pure astronomy are carried forward. Finally, both army and navy call upon chemical science to protect them against frauds. Supplies are purchased, either in foods or medicines, iron for ordnance, paints and varnishes for ship-yards, clothing for men, etc.; and the question whether the articles provided are of proper quality is constantly being raised. So analyses are made; and for this purpose each branch of the service maintains laboratories, and chemists are kept continually at work.

Attached to the army, and yet having no definite relations to military work, we find the Weather Service. This fairly represents a class of organizations which protect, not the nation as such, but rather the industries of the people. It warns the ship-owner of a coming storm, or cautions the fruit-grower or sugar-planter against a cold wave, and so assists in making industry surer of a fair return. A similar purpose is fulfilled by the Lighthouse Board, which, attached to the Treasury

Department, attends to the proper illumination of our coasts and rivers. One research of Joseph Henry's upon the oils used for light-house lamps saved the Government hundreds of thousands of dollars; and, to-day, the application of the electric light to coast illumination calls for the most careful consideration of scientific experts. The Department of Agriculture also does much in the application of scientific research to the assistance of great industries. It investigates the wasting of our forests, determines the conditions favorable to crops, conducts experiments upon sorghum, studies the plagues which ravage our flocks and herds, and seeks for methods of exterminating insect pests, such as the locust, the cotton-worm, or the potato-beetle. It employs chemists, botanists, entomologists, microscopists, and veterinary surgeons; and their labors can not but be fruitful of much good. Like it in aim, though working in a different direction, is the younger Fish Commission, which restocks our depleted waters, investigates the habits and food of fishes and the best modes of preventing their extermination, and literally creates new sources of wealth for the people.

Under the Treasury Department, in addition to the Lighthouse Board, are several other bureaus which depend more or less upon science. The Mint and Assay Offices, for example, have much to do with chemistry; and, to a certain extent, with physical problems also. The Bureau of Engraving and Printing, which manufactures our national bonds and notes, often has need of assistance from scientific experts; and so too have the custom-houses in the settlement of questions relative to certain duties. The Coast and Geodetic Survey, which is almost purely scientific in character, not only maps our coast-line with the utmost accuracy, but also furnishes the primary triangulation of the interior. This triangulation is the basis for all accurate mapping of the several States, and is done by men of the highest scientific training. An error in the boundary-line between two States may throw doubt upon the transfer, taxation, or inheritance of real property; or, by calling in question the jurisdiction of a court over disputed territories, it may defeat the ends of justice. Hitherto, when such doubts have arisen concerning State boundaries, the United States Government, represented by the Coast Survey, has been the arbiter. This survey also controls our magnetic observatories, in which the variations of the needle are recorded, and has custody of the standard weights and measures. The latter duty is one of the utmost importance, and involves the use of the most delicate instruments of precision.

The Geological Survey is under the Interior Department, and has several functions. It determines the geological structure of the country, joining and completing the scattered details of the several State surveys, develops more fully the principles of geologic science; and, from an economic point of view, investigates our mineral resources.

Its researches tend to increase the value of public lands, and to render the mineral industries of the nation more surely remunerative, productive, and definite. These industries already yield not far from five hundred millions of dollars annually, and accurate knowledge concerning them is essential to intelligent government. For, one function of government is to levy taxes; taxation, in the last analysis, falls upon the resources of a country, and it can not be wisely adjusted unless the resources are well known. A government can not even be truly economical unless its taxes are laid intelligently. Furthermore, the Geological Survey deals with the topography of the country, and prepares detailed maps of great utility. If such maps had been available during the late civil war, our armies would have been spared many difficulties, and the Government would have avoided much expense.

The Patent-Office also comes under the Interior Department; and here again we find great scientific activity, and a large corps of scientific experts. Their duties appear simple enough when superficially stated, but if studied closely they reveal the unexpected fact that the Government really has become the arbiter in doubtful questions of scientific priority. This is especially true in applied chemistry and electricity, and the controversies over the telephone may be cited as cases in point.

Of the other departments of the executive, little need be said. The Post-Office often needs chemical work on paper, fibers, inks, or other supplies. Questions often arise concerning the electric lighting of public buildings; and even the State Department sometimes has to handle matters of international science, as, for example, in the organization of the late conference relative to a common prime meridian of longitude. The Smithsonian Institution need not be considered, inasmuch as it is maintained by a private endowment, of which the United States is merely the trustee; but the National Museum, which is in charge of the Smithsonian regents, may be cited as the repository of valuable public treasures, and as the place in which the material resources of the country are visibly illustrated.

Enough has been said in the foregoing pages, though very incompletely, to indicate what an amount of scientific investigation and experiment our Government is obliged to require. In addition to these labors of an immediately necessary character, other scientific work is frequently carried on at Government expense, which aims at the discovery of truth for its own sake, apart from its direct applications. For examples, the transit of Venus and solar eclipse expeditions may be named, as well as the work carried on by the Bureau of Ethnology. In the latter organization, by Government aid, valuable data are saved which would otherwise be lost to science; and this is as it should be. Too often, in our busy, every-day life, we forget that there can be no applied science unless there is some pure science to apply; and that the larger problems of science, including much of material value to

mankind, are too vast to be grappled by unaided individuals or even by private corporations. They can be solved only by the combined efforts of many trained experts, working with the best facilities and under systematic direction, a state of affairs which can only be brought about by governmental assistance. When that stops, science languishes; and the growth of every industry, public or private, dependent upon science, is checked. Since every modern government is necessarily in competition with other governments, either in the way of increasing its resources or perfecting its means of defense, it follows that aid to science is one of the factors essential to success; and that that nation which fails in far-sighted intelligence will lag behind in material affairs also. Science, both pure and applied, has become a necessity, upon which the welfare and very life of nations must depend. No nation can fairly expect to receive all the benefits of science while giving nothing in return. Even the narrowest utilitarian must see what vast results sprang from the niggardly public grant which rendered possible the first line of the Morse telegraph.

But how shall aid be given? At present, the scientific work of the Government is done in a somewhat scattered way, with more or less overlapping and duplication, and not always under the most favorable circumstances. Some things which ought to be done are neglected, as, for instance, the systematic investigation of pestilences, such as the cholera and yellow fever; others are done twice over by different executive departments acting independently. In the army and navy, apart from the strictly professional researches which the officers are peculiarly fitted to carry on, some scientific work is done in a decidedly amateurish way. Officers are sometimes detailed to make experiments for which they have no special training, and for which civilian experts should be employed; just as if military or naval rank conferred upon its holder an *ex officio* knowledge, applicable everywhere. A naval officer, staff or line, spends three years at sea. He returns to three years of duty on shore, quite rusty as regards pure science, and is ordered to take charge of some laboratory, or to conduct the preparation of some special scientific report. He goes to work as best he may, and after a while his services begin to have real scientific value. Then he is sent to sea again, and some other lately returned victim takes his place. His best efforts are wasted, and science suffers; not because of his fault, but in consequence of a bad system. Fortunately, the system affects only a small part of our scientific services; for both army and navy employ specialists in various lines of investigation: as in the Weather Bureau, the Observatory, the Torpedo Station, and the preparation of the Nautical Almanac. Sometimes, however, it is anything but pleasant to see men of science of established reputation subordinated to some unscientific officer under the supercilious title of "civilian assistants." Full credit and responsibility should be given where they properly belong.

There can be no doubt that the present diffused character of the scientific service is due to the circumstances of its growth. Each feature of it has been developed when and where it was needed, without reference to similar work in other departments; hence the lack of system and the tendency to repetition. But the time for a change seems to be approaching; and it is probable that within a few years the strictly scientific work of the Government will be brought together under systematic control and a common head, and possibly in a new executive department. From such an arrangement the exclusively professional scientific investigations of the army and navy might properly be excepted; leaving whatever relates merely to warfare just where it is now. A department such as is here suggested would consolidate all the national surveys, would contain a national laboratory for the chemical and physical work of the Government, and would control the National Observatory, the Weather Service, and other kindred bureaus. It should be as far removed from political control as are the army, the navy, and the judiciary; its head should be a man of high scientific attainments and tried executive capacity; and each of its chiefs of division should have established reputation in the branch of science with which his duties had to deal. In brief, the officers of a Department of Science should have, relatively to their professions, as high standing as is required in the appointment of Justices of the Supreme Court. On that basis only can the scientific work of the Government attain its maximum efficiency. Although good work is done now, the very best is needed; and the standard can not be set too high. If the proposed consolidation of interests should prove to be not feasible, then some form of affiliation, under guidance of an advisory board of commissioners, might be tried. Either plan would insure greater economy and effectiveness than we have at present, and do away with needless duplications. There may be reasonable differences of opinion as to the best methods of organization; but there is no doubt that improvement is needed.

A discussion of the relations between science and politics, however, covers a broader range than the preceding pages have indicated. That a rational government has need of science, is plain enough; but what return influence does science exert upon the governing power? In what way will the subtile spread of scientific conceptions and methods of thinking affect legislation and government generally? So far we have considered only the material side of the question, but it has an intellectual aspect also, and speculation on this topic is too tempting to be wholly avoided.

As nearly as may be estimated, about forty-five per cent of the members of the present Congress have received a more or less complete college training. This proportion is large enough to show a preference on the part of the people for presumably educated representatives; for the ratio of college-bred men to the mass of any ordinary commu-

nity is vastly smaller. As the poorer and more remote portions of our country become richer and more populous, new colleges will spring up, and the older institutions at the same time are likely to gain in wealth and resources. This condition of affairs will, most probably, lead to an increase in the scholarly element among our legislative bodies; but, be that as it may, another tendency in education more directly concerns our argument. To-day most of our college graduates have received what is known as a "classical" training; in which science, as such, has been allowed to exercise a minimum of influence. But science, nevertheless, is steadily gaining ground; step by step it secures wider recognition and makes a stronger showing in the college courses; and the inevitable result will be that in a few years no man can be considered well educated who has not at least a fair knowledge of some scientific subject. That knowledge, moreover, will have to be gained by modern scientific methods; not from books alone, but by personal observation of things themselves, with the microscope, in the field, or in the college laboratories. In brief, the scholar of the future, whatever else he may have learned, will have received some training in the observation of phenomena at first hand, and in the science of drawing correct conclusions from them. We may, therefore, reasonably expect, as one result of all these tendencies taken together, to see in Congress a steadily increasing number of men acquainted with scientific work, accustomed to scientific modes of thought, and capable of estimating science at its true value, without indifference, and without exaggeration. Such a state of affairs can not fail to exert some influence upon legislation. It will provoke no startling revolutions, and, outwardly, to superficial observers, its effects may be scarcely perceptible; but they will be none the less permanent and real. Both in nature and society the quiet forces are the strongest; and reforms which are brought about almost unconsciously are oftentimes the farthest reaching. The results of a slight change in the mental habits of a Legislature may outweigh the consequences of a war.

Some of the results to be expected from the indicated change are so obvious as to need only the barest mention here. Naturally, the scientific work of the Government would receive more careful attention and be more judiciously fostered than it has been hitherto; its growth would be more symmetrical, and it would come more certainly under competent control. The legislation relating to coinage, weights, measures, etc., would become more intelligent, for the law-making power would be more directly familiar with the principles involved, and prejudices would have diminished influence. Furthermore, every legislative problem to which the scientific method of investigation could fairly be applied would have an increased chance of wise, judicious treatment. Of course, I do not mean to imply that miracles would be wrought, transforming human nature; parties and antagonisms would remain pretty much as they are now; only points of view

would be different, and some of the stumbling-blocks in the way of prudent legislation would have been removed. An argument in favor of definite improvement does not involve a belief in Utopia.

As an example of the problems capable of scientific treatment, let us consider the tariff question. A man who is actively engaged in commerce, manufactures, agriculture, or mining, will, consciously or unconsciously, regard such a problem from the stand-point of his own industry—judging it according to his own interests, and giving less weight to the interests of others. Whatever benefits him must be good for the country; whatever injures him is surely bad for the country: practical experience and common sense are apparently on his side. Nevertheless, with him, a truly judicial treatment of the subject is so difficult as to be well-nigh impossible; and this statement is borne out by the existing condition of affairs. Every great industry in the country has either been represented in Congress, or has clamored for relief before it, each asking that certain duties should be raised, and others abolished or lowered. The result of this agitation is practically chaos. Some industries are overburdened, and others are unduly favored; inequalities appear in every direction; a fair adjustment seems to be almost unattainable. The tariff, so far, has been framed unsystematically; the treatment of the question has been unscientific; hap-hazard experimenting has wrought unmistakable mischief.

Suppose, now, that the tariff problem were brought for solution before men of scientific training. They would look at it much as they would regard a question in mathematics; as an equation having two sides to be exactly balanced. First, they would group together the objects capable of taxation by import duties, classifying them by a scientific method, and specifying each one with definiteness and precision. The list so formed would next be simplified as much as possible, by striking out repetitions and superfluities, and making as few general headings as would properly cover the ground. Then would follow the consideration of each group by itself, with reference to the amount of revenue needed by the Government, and to the possible prohibitive character of any given rate of duty. Finally, the effects of the tariff upon consumers and producers would be taken into account, and the relations of industries to each other would be carefully studied, so that a duty favorable to one should not be destructive toward another. Thus, step by step, there would be wrought out a tariff system as even and just as possible; not an ideal system by any means, but one moderate and practicable.

Now, although at first sight it would seem to be a simple matter to adjust such a tariff system, something which any steady-going man of average common sense could attend to, a little consideration will show where the value of a scientific education comes in. First, the rigid application of the method proposed is more likely to be carried out by a man of scientific training than by any other, or at least more

nearly carried out; for the mode of procedure is just that which best fits the solution of scientific problems. The same mental habits are required in both directions; and, other things being equal, the man best trained in such habits will succeed best in handling either class of questions. Secondly, a tariff most directly affects manufactures; for the articles which it considers are either manufactured or used in manufacturing. Nearly every important manufacture of the present day involves applications of science, which ramify from industry to industry in the most complex way. If, therefore, we wish to study intelligently the relations of manufactures to each other, we must bear in mind the principles of the sciences so applied. Or, to speak more moderately and to the point, a knowledge of science is of direct use in attacking the tariff question. Two illustrations may serve to emphasize this argument:

Sulphuric acid is used in vast quantities in various manufacturing industries, and in this country it is mostly made from Sicilian sulphur. Some years ago a committee of Congress, adjusting a tariff, proposed to tax the sulphur, but to admit the acid duty free; the two things being considered separately, and without thought of their industrial relations to each other. Fortunately, the mistake was pointed out and corrected in the committee-room; but, if the error had become law, the production of sulphuric acid in the United States would have been stopped, and every industry using the acid would have been affected. For instance, the manufacturer of fertilizers would be directly concerned in the consequences of such legislation, and through him it would touch the farmers.

My second illustration is of a different kind. When a tariff is to be framed or modified, the old strife between free-trade and protection is renewed. The advocates of the latter policy urge that in the long run protection, by favoring competition, lowers prices and benefits the consumer; and, for evidence, they cite the present cheapness of iron and steel. A man of scientific education, working upon a tariff scheme, would hear this argument, and ask two questions concerning the case in point: First, is the alleged cheapening of iron real, or only apparent and due to a redistribution of ratios? Secondly, if it is real, how much of it has been caused by tariff legislation, and how much by the improvements which science has made in the production of iron? Upon the answers to these questions his final action will depend; for no intelligent estimate of the relations between the tariff and the iron industry could be framed independently of such answers. The fact that science is all the time modifying industrial processes complicates the issue between different tariff systems to an extent which only a man of scientific knowledge can fairly appreciate.

In 1794, during the Reign of Terror, Lavoisier, the greatest chemist of his time and an able statesman as well, was sentenced to the guillotine. Futile attempts were made to secure him a reprieve, in order

that certain important researches, then under way, might be completed; but the appeals in his behalf were met by a brutal reply: "The republic has no need of *savants*." Such was the spirit of ignorance in politics, as opposed to the spirit of science; and yet the event was so recent in history that another distinguished French chemist, Chevreul, who is still living and at work, was then eight years old. Contemporary with Lavoisier, Franklin and Rumford were eminent alike in science and in statesmanship to a degree equaled in either department by very few; and to-day Lyon Playfair, John Lubbock, and Professor Virchow are conspicuous both as investigators and in political life. In Italy, Quintino Sella has been illustrious as geologist, crystallographer, and statesman; and in our own country several men of science have shown their fitness for public affairs, and their capacity for usefulness as legislators. The "scholar in politics" may be out of place from the partisan's point of view, but not from the true statesman's. A closet scholar, who lives only in books, a visionary theorist, or a mere popular lecturer, who reflects the thoughts of others, may lack the qualities which fit a man for dealing with practical measures; but, for the careful scientific investigator who studies things for what they are, with neither fear nor prejudice, a place is surely open. Every one must admit the need of real knowledge, intelligence, and thoughtfulness in parliaments and congresses; and among the statesmen of the future, side by side with the jurist, the diplomat, and the financier, the man of science will stand as a coadjutor and equal. The dictum of the French judge is already reversed: the republic *has* need of *savants*.

THE DARWINIAN THEORY OF INSTINCT.*

By GEORGE J. ROMANES, F. R. S.

"GAVEST thou the goodly wings unto the peacocks? or wings and feathers unto the ostrich? which leaveth her eggs in the earth, and warmeth them in dust, and forgetteth that the foot may crush them, or that the wild beast may break them. . . . Because God hath deprived her of wisdom, neither hath he imparted to her understanding."

This is the oldest theory of instinct. The writer of that sublime monument of literary power in which it occurs observed a failure of instinct on the part of the ostrich, and forthwith attributed the fact to neglect on the part of the Deity; the implication plainly being that in all cases where instinct is perfect, or completely suited to the

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needs of the animal presenting it, the perfection is to be attributed to a God-given faculty of wisdom. This, I say, is the oldest theory of instinct, and I may add that until within the past twenty-five years it has been the only theory of instinct. I think, therefore, I ought to begin by explaining that this venerable and time-honored theory is a purely theological explanation of the ultimate source of instinct, and therefore can not be affected by any scientific theory as to the proximate causes. It is with such a theory alone that we shall here be concerned.

"When giants build, men must bring the stones." For the past eight or ten years I have been engaged in elaborating Mr. Darwin's theories in the domain of psychology, and I can not allude to my own work in this connection without expressing the deep obligations under which I lie to his ever-ready and ever-generous assistance—assistance rendered not only in the way of conversation and correspondence, but also by his kindness in making over to me all his unpublished manuscripts, together with the notes and clippings which he had been making for the past forty years in psychological matters. I have now gone carefully through all this material, and have published most of it in my work on "Mental Evolution in Animals." I allude to this work on the present occasion in order to observe that, as it has so recently come out, I shall feel myself entitled to assume that few have read it; and therefore I shall not cramp my remarks by seeking to avoid any of the facts or arguments therein contained.

As there are not many words within the compass of our language which have had their meanings less definitely fixed than the word "instinct," it is necessary that I should begin by clearly defining the sense in which I shall use it.

In general literature and conversation we usually find that instinct is antithetically opposed to reason, and this in such wise that, while the mental operations of the lower animals are termed instinctive, those of man are termed rational. This rough-and-ready attempt at psychological classification has descended to us from remote antiquity, and, like kindred attempts at zoölogical classification, is not a bad one so far as it goes. To divide the animal kingdom into beasts, fowls, fish, and creeping things, is a truly scientific classification as far as it goes, only it does not go far enough for the requirements of more careful observation; that is to say, it only recognizes the more obvious and sometimes only superficial differences, while it neglects the more hidden and usually more important resemblances. And to classify all the mental phenomena of animal life under the term "instinct," while reserving the term "reason" to designate a mental peculiarity distinctive of man, is to follow a similarly archaic method. It is quite true that instinct preponderates in animals, while reason preponderates in man. This obvious fact is what the world has always seen, just as it saw that flying appeared to be distinctive of birds, and creeping of

reptiles. Nevertheless, a bat was all the while a mammal, and a pterodactyl was not a bird; and it admits of proof as definite, that what we call instinct in animals occurs in man, and that what we call reason in man occurs in animals. This, I mean, is the case if we wait to attach any definition to the words which we employ. It is quite evident that there is some difference between the mind of a man and the mind of a brute, and if, without waiting to ascertain what this difference is, we say that it consists in the presence or absence of the faculty of reason, we are making the same kind of mistake as when we say that the difference between a bird and a mammal consists in the presence or absence of the faculty of flying. Of course, if we choose, we may employ the word "reason" to signify all the differences taken together, whatever they may be; and so, if we like, we may use the word "flying." But in either case we should be talking nonsense, because we should be divesting the words of their meaning, or proper sense. The meaning of the word "reason" is the faculty of ratiocination—the faculty of drawing inferences from a perceived equivalency of relations, no matter whether the relations involve the simplest mental perceptions, or the most abstruse mathematical calculations. And in this, the only real and proper sense of the word, reason is not the special prerogative of man, but occurs through the zoölogical scale at least as far down as the articulata.

What, then, is to be our definition of instinct?

First of all, instinct involves *mental* operation, and therefore implies *consciousness.* This is the point which distinguishes instinct from reflex action. Unless we assume that a new-born infant, for example, is conscious of sucking, it is as great a misnomer to term its adaptive movements in the performance of this act instinctive as it would be similarly to term the adaptive movements of its stomach subsequently performing the act of digestion.

Next, instinct implies hereditary knowledge of the objects and relations with respect to which it is exercised; it may therefore operate in full perfection prior to any experience on the part of the individual. When the pupa of a bee, for instance, changes into an imago, it passes suddenly from one set of experiences to another—the difference between its previous life as a larva and its new life as an imago being as great as the difference between the lives of two animals belonging to two different sub-kingdoms; yet as soon as its wings are dry it exhibits all the complex instincts of the mature insect in full perfection. And the same is true of the instincts of vertebrated animals, as we know from the researches of the late Mr. Douglas Spalding and others.

Again, instinct does not imply any necessary knowledge of the relation between means employed and ends attained. Such knowledge may be present in any degree of distinctness, or it may not be present at all; but in any case it is immaterial to the exercise of the instinct. Take, for example, the instinct of the Bembex. This insect brings

from time to time fresh food to her young, and remembers very exactly the entrance to her cell, although she has covered it with sand, so as not to be distinguishable from the surrounding surface. Yet M. Fabre found that if he brushed away the earth and the underground passage leading to the nursery, thus exposing the contained larva, the parent insect "was quite at a loss, and did not even recognize her own offspring. It seemed as if she knew the doors, nursery, and the passage, but not her child."

Lastly, instinct is always similarly manifested under similar circumstances by all the individuals of the same species. And, it may be added, these circumstances are always such as have been of frequent occurrence in the life-history of the species.

Now, in all these respects instinct differs conspicuously from every other faculty of mind, and especially from reason. Therefore, to gather up all these *differentiæ* into one definition, we may say that instinct is the name given to those faculties of mind which are concerned in consciously adaptive action, prior to individual experience, without necessary knowledge of the relation between means employed and ends attained; but similarly performed under similar and frequently recurring circumstances by all the individuals of the same species.

Such being my definition of instinct, I shall now pass on to consider Mr. Darwin's theory of the origin and development of instincts.

Now, to begin with, Mr. Darwin's theory does not, as many suppose that it does, ascribe the origin and development of all instincts to natural selection. This theory does, indeed, suppose that natural selection is an important factor in the process; but it neither supposes that it is the only factor, nor even that in the case of numberless instincts it has had anything at all to do with their formation. Take, for example, the instinct of wildness, or of hereditary fear as directed toward any particular enemy—say man. It has been the experience of travelers who have first visited oceanic islands without human inhabitants, and previously unvisited by man, that the animals are destitute of any fear of man. Under such circumstances the birds have been known to alight on the heads and shoulders of the new-comers, and wolves to come and eat meat held in one hand while a knife was held ready to slay them with the other. But this primitive fearlessness of man gradually passes into an hereditary instinct of wildness, as the special experiences of man's proclivities accumulate; and, as this instinct is of too rapid a growth to admit of our attributing it to natural selection (not one per cent of the animals having been destroyed before the instinct is developed), we can only attribute its growth to the effects of inherited observation. In other words, just as, in the lifetime of the individual, adjustive actions which were originally intelligent may by frequent repetition become automatic, so in the lifetime of the species, actions originally intelligent may, by frequent repetition and heredity, so write their effects on the nervous system

that the latter is prepared, even before individual experience, to perform adjustive actions mechanically which, in previous generations, were performed intelligently. This mode of origin of instincts has been called by Mr. Lewes the "lapsing of intelligence," and it was fully recognized by Mr. Darwin as a factor in the formation of instinct.

The Darwinian theory of instinct, then, attributes the evolution of instincts to these two causes acting either singly or in combination—natural selection and lapsing intelligence. I shall now proceed to adduce some of the more important facts and considerations which, to the best of my judgment, support this theory, and show it to be by far the most comprehensive and satisfactory explanation of the phenomena which has hitherto been propounded.

That many instincts must have owed their origin and development to natural selection exclusively is, I think, rendered evident by the following general considerations:

1. Considering the great importance of instincts to species, we are prepared to expect that they must be in large part subject to the influence of natural selection. 2. Many instinctive actions are performed by animals too low in the scale to admit of our supposing that the adjustments which are now instinctive can ever have been intelligent. 3. Among the higher animals instinctive actions are performed at an age before intelligence, or the power of learning by individual experience, has begun to assert itself 4. Many instincts, as we now find them, are of a kind which, although performed by intelligent animals at a matured age, yet can obviously never have been originated by intelligent observation. Take, for instance, the instinct of incubation. It is quite impossible that any animal, prior to individual or ancestral experience, can have kept its eggs warm with the intelligent purpose of developing their contents; so we can only suppose that the incubating instinct began in some such form as we now see it in the spider, where the object of the process is protection, as distinguished from the imparting of heat. But incidental to such protection in the case of a warm-blooded animal is the imparting of heat, and, as animals gradually became warm-blooded, no doubt this latter function became of more and more importance to incubation. Consequently, those individuals which most constantly cuddled their eggs would develop most progeny, and so the incubating instinct would be developed by natural selection without there ever having been any intelligence in the matter.

From these four general considerations, therefore, we may conclude (without waiting to give special illustrations of each) that one mode of origin of instincts consists in natural selection, or survival of the fittest, continuously preserving actions which, although never intelligent, yet happen to have been of benefit to the animals which first chanced to perform them. Among animals, both in a state of nature and domes-

tication, we constantly meet with individual peculiarities of disposition and of habit, which in themselves are utterly meaningless, and therefore quite useless. But it is easy to see that, if, among a number of such meaningless or fortuitous psychological variations, any one arises which happens to be of use, this variation would be seized upon, intensified, and fostered by natural selection, just as in the analogous case of structures. Moreover, there is evidence that such fortuitous variations in the psychology of animals (whether useless or accidentally useful) are frequently inherited, so as to become distinctive, not merely of individuals, but of races or strains. Thus, among Mr. Darwin's manuscripts, I find a letter from Mr. Thwaites, under the date of 1860, saying that all his domestic ducks in Ceylon had quite lost their natural instincts with regard to water, which they would never enter unless driven, and that, when the young birds were thus compelled to enter the water, they had to be quickly taken out again to prevent them from drowning. Mr. Thwaites adds that this peculiarity only occurs in one particular breed. Tumbler-pigeons instinctively tumbling, pouter-pigeons instinctively pouting, etc., are further illustrations of the same general fact.

Coming now to instincts developed by lapsing intelligence, I have already alluded to the acquisition of an hereditary fear of man as an instance of this class. Now, not only may the hereditary fear of man be thus acquired through the observation of ancestors—and this even to the extent of knowing by instinct what constitutes safe distance from fire-arms—but, conversely, when fully formed it may again be lost by disuse. Thus, there is no animal more wild, or difficult to tame, than the young of the wild rabbit; while there is no animal more tame than the young of the domestic rabbit. And the same remark applies, though in a somewhat lesser degree, to the young of the wild and of the domestic duck. For, according to Dr. Rae, "if the eggs of a wild duck are placed with those of a tame duck under a hen to be hatched, the ducklings from the former, on the very day they leave the egg, will immediately endeavor to hide themselves, or take to the water, if there be any water, should any one approach, while the young from the tame duck's eggs will show little or no alarm." Now, as neither rabbits nor ducks are likely to have been selected by man to breed from on account of tameness, we may set down the loss of wildness in the domestic breeds to the uncompounded effects of hereditary memory of man as a harmless animal, just as we attributed the original acquisition of instinctive wildness to the hereditary memory of man as a dangerous animal; in neither case can we suppose that the principle of selection has operated in any considerable degree.

Thus far, for the sake of clearness, I have dealt separately with these two factors in the formation of instinct—natural selection and lapsing intelligence—and have sought to show that either of them

working singly is sufficient to develop some instincts. But, no doubt, in the case of most instincts intelligence and natural selection have gone hand in hand, or co-operated, in producing the observed results —natural selection always securing and rendering permanent any advances which intelligence may have made. Thus, to take one case as an illustration. Dr. Rae tells me that the grouse of North America have the curious instinct of burrowing a tunnel just below the surface of the snow. In the end of this tunnel they sleep securely, for when any four-footed enemy approaches the mouth of the tunnel, the bird, in order to escape, has only to fly up through the thin covering of snow. Now, in this case the grouse probably began to burrow in the snow for the sake of warmth, or concealment, or both; and, if so, thus far the burrowing was an act of intelligence. But the longer the tunnel the better would it serve in the above-described means of escape; therefore natural selection would tend to preserve the birds which made the longest tunnels, until the utmost benefit that length of tunnel could give had been attained.

And similarly, I believe, all the host of animal instincts may be fully explained by the joint operation of these two causes—intelligent adjustment and survival of the fittest. For now I may draw attention to another fact which is of great importance, viz., that instincts admit of being modified as modifying circumstances may require. In other words, instincts are not rigidly fixed, but are plastic, and their plasticity renders them capable of improvement or of alteration, according as intelligent observation requires. The assistance which is thus rendered by intelligence to natural selection must obviously be very great, for under any change in the surrounding conditions of life which calls for a corresponding change in the ancestral instincts of the animal, natural selection is not left to wait, as it were, for the required variations to arise fortuitously; but is from the first furnished by the intelligence of the animal with the particular variations which are needed.

In order to demonstrate this principle of the variation of instinct under the guidance of intelligence, I may here introduce a few examples.

Huber observes, "How ductile is the instinct of bees, and how readily it adapts itself to the place, the circumstances, and the needs of the community!" Thus, by means of contrivances which I need not here explain, he forced the bees either to cease building combs, or to change their instinctive mode of building from above downward, to building in the reverse direction, and also horizontally. The bees in each case changed their mode of building accordingly. Again, an irregular piece of comb, when placed by Huber on a smooth table, tottered so much that the bumble-bees could not work on so unsteady a basis. To prevent the tottering, two or three bees held the comb by fixing their front-feet on the table, and their hind-feet on the comb.

This they continued to do, relieving guard, for three days, until they had built supporting pillars of wax. Some other bumble-bees, when shut up and so prevented from getting moss wherewith to cover their nests, tore threads from a piece of cloth, and "carded them with their feet into a fretted mass," which they used as moss. Lastly, Andrew Knight observed that his bees availed themselves of a kind of cement made of rosin and turpentine, with which he had covered some decorticated trees—using this ready-made material instead of their own propolis, the manufacture of which they discontinued; and more recently it has been observed that bees, "instead of searching for pollen, will gladly avail themselves of a very different substance, namely, oatmeal." Now, in all these cases it is evident that, if, from any change of environment, such accidental conditions were to occur in a state of nature, the bees would be ready at any time to meet them by intelligent adjustment, which, if continued sufficiently long and aided by selection, would pass into true instincts of building combs in new directions, of supporting combs during their construction, of carding threads of cloth, of substituting cement for propolis and oatmeal for pollen.

Turning to higher animals, Andrew Knight tells us of a bird which, having built her nest upon a forcing-house, ceased to visit it during the day when the heat of the house was sufficient to incubate the eggs; but always returned to sit upon the eggs at night when the temperature of the house fell. Again, thread and worsted are now habitually used by sundry species of birds in building their nests, instead of wool and horse-hair, which in turn were no doubt originally substitutes for vegetable fibers and grasses. This is especially noticeable in the case of the tailor-bird, which finds thread the best material wherewith to sew. The common house-sparrow furnishes another instance of intelligent adaptation of nest-building to circumstances, for in trees it builds a domed nest (presumably, therefore, the ancestral type), but in towns avails itself by preference of sheltered holes in buildings, where it can afford to save time and trouble by constructing a loosely-formed nest. Moreover, the chimney- and house-swallows have similarly changed their instincts of nidification, and in America this change has taken place within the last two or three hundred years. Indeed, according to Captain Elliott Coues, all the species of swallow on that continent (with one possible exception) have thus modified the sites and structures of their nests in accordance with the novel facilities afforded by the settlement of the country.

Another instructive case of an inteliigent change of instinct in connection with nest-building is given from a letter by Mr. Haust, dated New Zealand, 1862, which I find among Mr. Darwin's manuscripts. Mr. Haust says that the Paradise duck, which naturally or usually builds its nest along the rivers on the ground, has been observed by him on the east of the island, when disturbed in their nests upon the

ground, to build "new ones on the tops of high trees, afterward bringing their young ones down on their backs to the water"; and exactly the same thing has been recorded by another observer of the wild ducks of Guiana. Now, if intelligent adjustment to peculiar circumstances is thus adequate, not only to make a whole breed or species of bird transport their young upon their backs—or, as in the case of the woodcock, between their legs—but even to make web-footed water-fowl build their nests in high trees, I think we can have no doubt that if the need of such adjustment were of sufficiently long continuance, the intelligence which leads to it would eventually produce a new and remarkable modification of their ancestral instinct of nest-building.

Turning now from the instinct of nidification to that of incubation, I may give one example to show the plasticity of the instinct in relation to the observed requirements of progeny. Several years ago I placed, in the nest of a sitting Brahma hen, four newly-born ferrets. She took to them almost immediately, and remained with them for rather more than a fortnight, when I made a separation. During the whole of the time the hen had to sit upon the nest, for the young ferrets were not able to follow her about, as young chickens would have done. The hen was very much puzzled by the lethargy of her offspring, and two or three times a day she used to fly off the nest calling on her brood to follow; but, on hearing their cries of distress from cold, she always returned immediately, and sat with patience for six or seven hours more. I found that it only took the hen one day to learn the meaning of these cries of distress; for, after the first day, she would always run in an agitated manner to any place where I concealed the ferrets, provided that this place was not too far away from the nest to prevent her from hearing their cries. Yet I do not think it would be possible to imagine a greater contrast between two cries than the shrill, piping note of a young chicken and the hoarse, growling noise of a young ferret. At times the hen used to fly off the nest with a loud scream, which was doubtless due to the unaccustomed sensation of being nipped by the young ferrets in their search for the traditional source of mammalian nutriment. It is further worthy of remark that the hen showed so much anxiety when the ferrets were taken from the nest to be fed, that I adopted the plan of giving them the milk in their nest, and with this arrangement the hen seemed quite satisfied; at any rate she used to chuck when she saw the milk coming, and surveyed the feeding with evident satisfaction.

Thus we see that even the oldest and most important of instincts in bees and birds admit of being greatly modified, both in the individual and in the race, by intelligent adaptation to changed conditions of life; and therefore we can scarcely doubt that the principle of lapsing intelligence must be of much assistance to that of natural selection in the origination and development of instinct.

I shall now turn to another branch of the subject. From the

nature of the case, it is not to be expected that we should obtain a great variety of instances among wild animals of new instincts acquired under human observation, seeing that the conditions of their life, as a rule, remain pretty uniform for any periods over which human observation can extend. But from a time before the beginning of history, mankind, in the practice of domesticating animals, has been making what we may now deem a gigantic experiment upon the topic before us.

The influences of domestication upon the psychology of animals may be broadly considered as both negative and positive—negative in the obliteration of natural instincts; positive in the creation of artificial instincts. I shall consider these two branches separately, and here I may again revert to the obliteration of natural wildness. We all know that the horse is an easily breakable animal, but his nearest allies in a state of nature, the zebra and the quagga, are the most obstinately unbreakable of animals. Similar remarks apply to the natural wildness of all wild species of kine, as contrasted with the innate tameness of our domesticated breeds. Consider again the case of the cat. The domesticated animal is sufficiently tame, even from kittenhood; whereas its nearest cousin in a state of nature, the wild-cat, is perhaps of all animals the most untamable. But, of course, it is in the case of the dog that we meet with the strongest evidence on this point. The most general and characteristic features in the psychology of all the domesticated varieties are faithfulness, docility, and sense of dependence upon a master; whereas the most usual and characteristic features in the psychology of all the wild species are fierceness, treachery, and self-reliance. But, not further to pursue the negative side of this subject, let us now turn to the positive, or to the power which man has shown himself to possess of implanting new instincts in the mental constitution of animals. For the sake of brevity I shall here confine myself to the most conspicuous instance, which is of course furnished by the dog, seeing that the dog has always been selected and trained with more or less express reference to his mental qualities. And here I may observe that, in the process of modifying psychology by domestication, exactly the same principles have been brought into operation as those to which we attribute the modification of instincts in general; for the processes of artificial selection and training, in successive generations, are precisely analogous to the processes of natural selection and lapsing of intelligence in a state of nature.

Touching what Mr. Darwin calls the artificial instincts of the dog, I may first mention those which he has himself dilated upon—I mean the instincts of pointing, retrieving, and sheep-tending; but, as Mr. Darwin has already fully treated of these instincts, I need not go over the ground which he has traversed, and so shall confine myself to the consideration of another artificial instinct, which, although not men-

tioned by him, seems to me of no less significance—I mean the instinct of guarding property. This is a purely artificial instinct, created by man expressly for his own purposes: and it is now so strongly ingrained in the intelligence of the dog that it is unusual to find any individual animal in which it is wholly absent. Thus, we all know that, without any training, a dog will allow a stranger to pass by his master's gate without molestation, but that as soon as the stranger passes within the gate, and so trespasses upon what the dog knows to be his master's territory, the animal immediately begins to bark, in order to give his master notice of the invasion. And this leads me to observe that barking is in itself an artificial instinct, developed, I believe, as an offshoot from the more general instinct of guarding property. None of the wild species of dog are known to bark, and therefore we must conclude that barking is an artificial instinct, acquired by the domestic dog for the purpose of notifying to his master the presence of thieves or enemies. I may further observe that this instinct of guarding property extends to the formation of an instinctive idea on the part of the animal, of itself as constituting part of that property. If, for instance, a friend gives you temporary charge of his dog, even although the dog may never have seen you before, observing that you are his master's friend and that his master intends you to take charge of him, he immediately transfers his allegiance from his master to you, as to a deputed owner, and will then follow you through any number of crowded streets with the utmost confidence. Thus, whether we look to the negative or to the positive influences of domestication upon the psychology of the dog, we must conclude that a change has been wrought, so profound that the whole mental constitution of the animal now presents a more express reference to the needs of another, and his enslaving animal, than it does to his own. Indeed, we may say that there is no one feature in the whole psychology of the dog which has been left unaltered by the influence of man, excepting only those instincts which, being neither useful nor harmful to man, have never been subject to his operation—such, for instance, as the instinct of burying food, turning round to make a bed before lying down, etc.

I will now turn to another branch of the subject, and one which, although in my opinion of the greatest importance, has never before been alluded to; I mean the local and specific variations of instinct. By a local variation of instinct, I mean a variation presented by a species in a state of nature over some particular area of geographical distribution. It is easy to see the importance of such local variations of instinct as evidence of the transmutation of instinct, if we reflect that such a local variation is obviously on its way to becoming a new instinct. For example, the beavers in California have ceased to make dams, the hyenas in South Africa have ceased to make burrows, and there is a squirrel in the neighborhood of Mount Airy which has

developed carnivorous tastes—running about the trees, not to search for nuts, but to search for birds, the blood of which it sucks. In Ohinitahi there is a mountain parrot, which, before the settlement of the place was a honey-eater, but, when sheep were introduced, the birds found that mutton was more palatable to them than honey, and quickly abandoned their ancestral habits, exchanging their simple tastes of honey-eaters for the savageness of tearers of flesh. For the birds come in flocks, single out a sheep, tear out the wool, and when the sheep, exhausted by running about, falls upon its side, they bore into its abdominal cavity to get at the fat which surrounds the kidneys.

These, I think, are sufficient instances to show what I mean by local variations of instinct. Turning now to the specific variations, I think they constitute even stronger evidence of the transmutation of instinct; for where we find an instinct peculiar to a species, or not occurring in any other species of the genus, we have the strongest possible evidence of that particular instinct having been specially developed in that particular species. And this evidence is of particular cogency when, as sometimes happens, the change of instinct is associated with structures pointing to the state of the instincts before the change. Thus, for example, the dipper belongs to a non-aquatic family of birds, but has developed the instinct, peculiar to its species, of diving under water and running along the bottoms of streams. The species, however, has not had time, since the acquisition of this instinct, to develop any of the structures which in all aquatic families of birds are correlated with their aquatic instincts, such as webbed feet, etc. That is to say, the bird retains all its structural affinities, while departing from the family type as regards its instincts. A precisely converse case occurs in certain species of birds belonging to families which are aquatic in their affinities, these species, however, having lost their aquatic instincts. Such is the case, for example, with the upland geese. These are true geese in all their affinities, retaining the webbed feet, and all the structures suited to the display of aquatic instincts; yet they never visit the water. Similarly, there are species of parrots and tree-frogs, which, while still retaining the structures adapted to climbing trees, have entirely lost their arboreal habits. Now, short of actual historical or paleontological information—which of course in the case of instincts is unattainable, seeing that instincts, unlike structures, never occur in a fossil state—short, I say, of actual historical or paleontological information, we could have no stronger testimony to the fact of transmutation of instincts than is furnished by such cases, wherein a particular species, while departing from the instinctive habits of its nearest allies, still retains the structures which are only suited to the instincts now obsolete.

This last head of evidence—that, namely, as to local and specific variations of instincts—differs in one important respect from all the other heads of evidence which I have previously adduced. For, while

these other heads of evidence had reference to the theory concerning the *causes* of transmutation, this head of evidence has reference to the *fact* of transmutation. Whatever, therefore, we may think concerning the evidence of the causes, it is quite distinct from that on which I now rely as conclusive proof of the fact.

I shall now, for the sake of fairness, briefly allude to the more important cases of special difficulty which lie against Mr. Darwin's theory of the origin and development of instincts. For the sake of brevity, however, I shall not allude to those cases of special difficulty which he has himself treated in the "Origin of Species," but shall confine myself to considering the other and most formidable cases which, after surveying all the known instincts presented by animals, I have felt to be such.

First, we have the alleged instinct of the scorpion committing suicide when surrounded by fire. This instinct, if it really exists, would no doubt present a difficulty, because it is clearly an instinct which, being not only of no use, but actually detrimental both to the individual and the species, could never have been developed either by natural selection or by lapsing intelligence. I may, however, dismiss this case with a mere mention, because as yet the evidence of the fact is not sufficiently precise to admit of our definitely accepting it as a fact.

There can be no such doubt, however, attaching to another instinct largely prevalent among insects, and which is unquestionably detrimental, both to the individual and to the species. I allude to the instinct of flying through flame. This is unquestionably a true instinct, because it is manifested by all individuals of the same species. How, then, are we to explain its occurrence? I think we may do so by considering, in the first place, that flame is not a sufficiently common object in nature to lead to any express instinct for its avoidance; and in the next place by considering that insects unquestionably manifest a disposition to approach and examine shining objects. Whether this disposition is due to mere curiosity, or to a desire to ascertain if the shining objects will, like flowers, yield them food, is a question which need not here concern us. We have merely to deal with the fact that such a general disposition is displayed. Taking, then, this fact in connection with the fact that flame is not a sufficiently common object in nature to lead to any instinct expressly directed against its avoidance, it seems to me that the difficulty we are considering is a difficulty no longer.

The shamming-dead of insects appears at first sight a formidable difficulty, because it is impossible to understand how any insect can have acquired the idea of death or of its intentional simulation. This difficulty occurred to Mr. Darwin thirty or forty years ago, and among his manuscripts I find some very interesting notes of experiments upon the subject. He procured a number of insects which exhibited the instinct, and carefully noted the attitude in which they feigned death.

Some of these insects he then killed, and he found that in no case did the attitude in which they feigned death resemble the attitude in which they really died. Consequently we must conclude that all the instinct amounts to is that of remaining motionless, and therefore inconspicuous, in the presence of danger; and there is no more difficulty in understanding how such an instinct as this should be developed by natural selection in an animal which has no great powers of locomotion than there is in understanding how the instinct to run away from danger should be developed in another animal with powers of rapid locomotion. The case, however, is not, I think, quite so easy to understand in the feigning death of higher animals. From the evidence which I have I find it almost impossible to doubt that certain birds, foxes, wolves, and monkeys, not to mention some other and more doubtful cases, exhibit the peculiarity of appearing dead when captured by man. As all these animals are highly locomotive, we can not here attribute the fact to protective causes. Moreover, in these animals this behavior is not truly instinctive, inasmuch as it is not presented by all or even most individuals. As yet, however, observation of the facts is insufficient to furnish any data as to their explanation, although I may remark that possibly they may be due to the occurrence of the mesmeric or hypnotic state, which we know from recent researches may be induced in animals under the influence of forcible manipulation.

The instinct of feigning injury by certain birds presents a peculiar difficulty. As we all know, partridges, ducks, and plovers, when they have a brood of young ones, and are alarmed by the approach of a carnivorous quadruped, such as a dog, will pretend to be wounded, flapping along the ground with an apparently broken wing in order to induce the four-footed enemy to follow, and thus to give time for the young brood to disperse and hide themselves. The difficulty here, of course, is to understand how the birds can have acquired the idea of pretending to have a broken wing, for the occasions must be very rare on which any bird has seen a companion thus wounded followed by a carnivorous quadruped; and even if such observations on their part were of frequent occurrence, it would be difficult to accredit the animals with so high a degree of reasoning power as would be required for them intentionally to imitate such movements. When I consulted Mr. Darwin with reference to this difficulty, he gave me a provisional hypothesis by which it appeared to him that it might be met. He said that any one might observe, when a hen has a brood of young chickens and is threatened by a dog, that she will alternately rush at the dog and back again to the chickens. Now, if we could suppose that under these circumstances the mother-bird is sufficiently intelligent to observe that, when she runs away from the dog, she is followed by the dog, it is not impossible that the maternal instinct might induce her to run away from a brood in order to lead the dog away from it. If this happened in any cases, natural selection would

tend to preserve those mother-birds which adopted this device. I give this explanation as the only one which either Mr. Darwin or myself has been able to suggest. It will be observed, however, that it is unsatisfactory, inasmuch as it fails to account for the most peculiar feature of the instinct—I mean the trailing of the apparently wounded wing.

The instinct of migration furnishes another case of special difficulty, but, as I have no space to dwell upon the sundry questions which it presents for solution, I shall now pass on to the last of the special difficulties which most urgently call for consideration. The case to which I refer deserves, I think, to be regarded as the most extraordinary instinct in the world. There is a species of wasp-like insect, called the sphex. This insect lays its eggs in a hole excavated in the ground. It then flies away and finds a spider, which it stings in the main nerve-center of the animal. This has the effect of paralyzing the spider without killing it. The sphex then carries the now motionless spider to its nursery, and buries it with the eggs. When the eggs hatch out the grubs feed on the paralyzed prey, which is then still alive and therefore quite fresh, although it has never been able to move since the time when it was buried. Of course, the difficulty here is to understand how the sphex insect can have acquired so much anatomical and physiological knowledge concerning its prey as the facts imply. We might indeed, suppose, as I in the first instance was led to suppose, that the sting of the sphex and the nerve-center of the spider being both organs situated on the median line of their respective possessors, the striking of the nerve-center by the sting might in the first instance have been thus accidentally favored, and so have supplied a basis from which natural selection could work to the perfecting of an instinct always to sting in one particular spot. But more recently the French entomologist, M. Fabre, who first noticed these facts with reference to the stinging of the spider, has observed another species of sphex which preys upon the grasshopper, and, as the nervous system of a grasshopper is more elongated than the nervous system of a spider, the sphex in this case has to sting its prey in three successive nerve-centers in order to induce paralysis. Again, still more recently, M. Fabre has found another species of sphex which preys upon a caterpillar, and in this case the animal has to sting its victim in nine successive nerve-centers. On my consulting Mr. Darwin in reference to these astonishing facts, he wrote me the following letter:

"I have been thinking about Pompilius and its allies. Please take the trouble to read on perforation of the corolla, by bees, page 425, of my 'Cross-Fertilization,' to end of chapter. Bees show so much *intelligence* in their acts, that it seems not improbable to me that the progenitors of Pompilius originally stung caterpillars and spiders, etc., in any part of their bodies, and then observed by their intelli-

gence that if they stung them in one particular place, as between certain segments on the lower side, their prey was at once paralyzed. It does not seem to me at all incredible that this action should then become instinctive, i. e., memory transmitted from one generation to another. It does not seem necessary to suppose that, when Pompilius stung its prey in the ganglion, it intended, or knew, that the prey would keep long alive. The development of the larvæ may have been subsequently modified in relation to their half-dead, instead of wholly dead, prey; supposing that the prey was at first quite killed, which would have required much stinging. Turn over this in your mind, etc."

I confess that this explanation does not appear to me altogether satisfactory, although it is no doubt the best explanation that can be furnished on the lines of Mr. Darwin's theory.

In the brief time at my disposal, I have endeavored to give an outline sketch of the main features of the evidence which tends to show that animal instincts have been slowly evolved under the influence of natural causes, the discovery of which we owe to the genius of Darwin. And, following the example which he has set, I shall conclude by briefly glancing at a topic of wider interest and more general importance. The great chapter on instinct, in the "Origin of Species," is brought to a close in the following words:

"Finally, it may not be a logical deduction, but to my imagination it is far more satisfactory to look at such instincts as the young cuckoo ejecting its foster-brothers, ants making slaves, the larvæ of ichneumonidæ feeding within the live bodies of caterpillars, not as specially endowed or created instincts, but as small consequences of one general law leading to the advancement of all organic beings, namely, multiply, vary, let the strongest live, and the weakest die."

This law may seem to some, as it has seemed to me, a hard one—hard, I mean, as an answer to the question which most of us must at some time, and in some shape, have had faith enough to ask, "Shall not the Judge of all the earth do right?" For this is a law, rigorous and universal, that the race shall always be to the swift, the battle without fail to the strong; and in announcing it the voice of Science has proclaimed a strangely new beatitude—Blessed are the fit, for they shall inherit the earth. Surely these are hard sayings, for in the order of Nature they constitute might the only right. But, if we are thus led to feel a sort of moral repugnance to Darwinian teaching, let us conclude by looking at this matter a little more closely, and in the light that Darwin himself has flashed upon it in the short passage which I have quoted.

Eighteen centuries before the publication of this book—the "Origin of Species"—one of the founders of Christianity had said, in words as strong as any that have been used by the Schopenhauers and Hartmanns of to-day, "The whole creation groaneth in pain and travail." Therefore we did not need a Darwin to show us this terrible truth;

but we did need a Darwin to show us that, out of all the evil which we see, at least so much of good as we have known has come; that if this is a world of pain and sorrow, hunger, strife, and death, at least the suffering has not been altogether profitless; that whatever may be "the far-off divine event to which the whole creation moves," the whole creation, in all its pain and in all its travail, is certainly moving, and this in a direction which makes, if not for "righteousness," at all events for improvement. No doubt the origin of evil has proved a more difficult problem to solve than the origin of species; but, thus viewed, I think that the Darwinian doctrine deserves to be regarded as in some measure a mitigation of the difficulty—certainly in no case an aggravation of it. I do not deny that an immense residuum of difficulty remains, seeing that, so far as we can judge, the means employed certainly do not appear to be justified by the ends attained. But even here we ought not to lose sight of the possibility that, if we could see deeper into the mystery of things, we might find some further justification of the evil, as unsuspected as was that which, as it seems to me, Darwin has brought to light. It is not in itself impossible—perhaps it is not even improbable—that the higher instincts of man may be pointing with as true an aim as those lower instincts of the brutes which we have been contemplating. And, even if the theory of evolution were ever to succeed in furnishing as satisfactory an explanation of the natural development of the former as it has of the natural development of the latter, I think that the truest exponent of the meaning—as distinguished from the causation—of these higher instincts would still be, not the man of science, but the poet. Here, therefore, it seems to me, that men of science ought to leave the question of pain in Nature to be answered, so far as it can be answered, by the general voice of that humanity which we all share, and which is able to acknowledge that at least its own allotment of suffering is not an unmitigated evil.

"For clouds of sorrow deepness lend,
To change joy's early rays,
And manhood's eyes alone can send
A grief-ennobled gaze;

"While to that gaze alone expand
Those skies of fullest thought,
Beneath whose starlit vaults we stand,
Lone, wondering, and untaught."

"We look before and after,
And pine for what is not,
Our sincerest laughter
With some pain is fraught."

Yet still—

"Our sweetest songs are those that tell of saddest thought."

MEDICAL EXPERT TESTIMONY.*

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FROM time to time within the last few years, and perhaps for a longer period, comments have been made in the daily secular press, and occasionally in the medical journals, in reference to the testimony of medical experts, which were anything but flattering to medical men. These comments have, in most cases, had reference to their testimony as experts in cases of alleged lunacy, or in cases involving the question of moral responsibility. They have been charged with ignorance, incompetency, inconsistency, and in some cases with venality. It has been said that their opinions are purchasable.

In support of these grave charges the reader has been referred to the fact that an equal number of eminent experts can usually be found to testify on either side, and that in their testimony they often differ from each other irreconcilably. In other cases no evidence is offered to sustain the charges, except the fact that the opinions of the writer and of the public differ from that of the expert.

In what I shall have to say upon this subject I propose to confine myself to those examples in which the question involved is one of mental capacity and responsibility, as being that in which medical experts have been most often and most severely criticised. To a certain extent, however, you will observe that the arguments employed will apply to expert testimony in any other department of medicine or of science.

1. Medical men, whether they be specialists in the study of mental diseases or not, in the differentiation of the class of diseases now under consideration, labor under peculiar difficulties. There are many mental disorders which are unaccompanied with any recognizable abnormal physical conditions of the brain; that is to say, in which there are no structural lesions of the brain cognizable during life, or which can be satisfactorily demonstrated in the autopsy; and there are many in which the mental alienation can not be fairly traced to any lesions in any other part of the body. The number of these examples may hereafter be found to be smaller than is now known, but for the present the fact is as I have stated. That a functional disturbance of the brain exists in such cases is self-evident; but for aught we know this may be due to some slight molecular, chemical, or vital changes in the nerve-cells of the gray matter of the brain or of a group of cells, not denoted by any peculiar physical signs during life, and which can leave no possible traces after death. To cause mental

* Being a portion of the presidential address on "Medical Expert Testimony, especially in Cases involving the Question of Insanity," delivered before the Society of Medical Jurisprudence and State Medicine (New York), January 8, 1885.

derangement, it may be only necessary that these microscopic cells should be temporarily deprived of their normal supply of oxygen through the vascular system; or, on the other hand, a slight increase in the supply of the proper nutriment or stimulus may cause the same results. A simple loss of equilibrium, or change of tension in the nerve-cell, may cause delirium. These abnormal physical conditions may be temporary or permanent, but in either case they will probably, in the future as in the past, elude the most careful observation of the physician, the chemist, and the microscopist. Science has calculated the vibrations of the musical chord, and measured the oscillations of a ray of light, but has not estimated the vibrations of the living intellectual nerve-cell, nor analyzed its aura which waits incessantly and instantly upon its will. It has furnished no means, therefore, of determining mathematically when the mysterious organ of the mind is out of tune, or why its notes are discordant.

2. Hitherto no one has furnished a definition of insanity which will cover all of the supposed examples. Nor, considering the nature of the subject, is it probable that it will ever be done. It may be easy to differentiate a certain class of cases. We can say, without fear of contradiction, that a raving and uncontrollable maniac is insane, or that another, whose life has been uniformly consistent and harmonious, is sane. But this is not the class of cases in reference to which our opinions are asked. They do not give rise to litigation or dispute. Our opinions are only asked when there exists some room for doubt as to the exact mental condition of the person in question, and who therefore occupies a position near the border-lines which separate insanity from sanity; but no legal or scientific authority has established these lines. They are not indicated by broad rivers, or mountain-ranges, such as form the natural boundaries between nations; but the opposite conditions here become insensibly merged, in such a manner that no one can say where one ends and the other begins. One might as well attempt to determine the exact limits of the auroral lights.

Says Ray, in his classical treatise on "Mental Pathology," "One source, and perhaps the principal, of the prevalent error, is the habit of regarding insanity as a sharply defined phenomenon, easily separated from all accompanying incidents, like an earthquake or a chemical action, instead of a condition arising from obscure beginnings, culminating more or less rapidly, and declining by imperceptible steps, as the darkness of night is succeeded by the light of common day." In these doubtful cases the expert has to consider the possible motives of the individual, his hereditary tendencies, his education, social influences, his previous habits, his condition as to health or disease, and a multitude of other matters, all of which are to be carefully weighed and balanced against each other, before he can form a correct judgment as to whether a certain act or line of conduct implies insanity and irresponsibility or not. That there should not be exact,

or, in many cases, even approximate concurrence of opinion among experts of equal qualifications, is natural and ought to excite no surprise. Those are the unreasonable persons who expect anything else. Of course, it is desirable that there should be no disagreement, since in the decision of so nice a question one grain of testimony, more or less, cast into either scale may decide the life or liberty of the person whose case is before the court; but for the fallibility of human opinions, at least to the extent now supposed, no remedy has as yet been provided.

3. If it be true that expert testimony, when questions of sanity or of moral responsibility are involved, is often contradictory and irreconcilable, it is equally true of expert testimony where questions of much less complexity are involved. It is true in nearly all cases of dispute upon matters of science, art, or commerce. In the Feuardent Di Cesnola suit we have seen one expert in archæology affirm that a piece of statuary was as it came from the hands of the original artist, while another has declared with equal confidence that it was constructed from fragments obtained from different sources. In the investigation which followed the Ashtabula catastrophe, it was ascertained that one man, who was supposed to be both theoretically and practically acquainted with the construction of railroad-bridges, had declared this bridge to have been built according to the most approved system, and that it was perfectly safe, while another expert had expressed a contrary opinion; and this important question was left to be finally and definitively settled when the bridge had given way under the weight of a passing train, and twenty or more lives were lost.

Does it often happen, in any class of cases, that lawyers are unable to obtain expert testimony for their clients, in case they stand in need of it, or that the testimony on the two sides is not conflicting?

Not alone experts, but lawyers also, if we can accept their own statements, do not often agree in opinion as to the merits of the cases of their respective clients. The courts also are far from uniformity in their decisions and their interpretation of the law and the facts.

It has been asked, "If witnesses are not suborned, how does it happen that experts so uniformly testify in the interest of the parties by whom they are employed?" As if it were a question which admitted of but one answer, namely, that the witness gave his testimony under oath, only as a consideration for the pay he was to receive, and without regard to the sanctity of his oath, or to the value of his reputation as a citizen and a man of science.

This question, asked no doubt seriously, will be answered seriously: Because no intelligent lawyer would call an expert witness to the stand until he had ascertained, after a full statement of the case to him, what his opinions were. He would not summon a witness who would certainly, or even possibly, damage the cause of his client.

It is fair to conclude, from the preceding statement of facts, that

the supposed evils of the present system of procuring expert testimony in cases of alleged lunacy have been greatly exaggerated, if they are not wholly imaginary. Such cases are not decided by the experts. Having given their opinions under a direct examination, they are subjected to a sharp cross-examination by skillful attorneys, who subsequently, and after sufficient time has been given for study and reflection, are permitted to argue the case to the jury. The judges comment upon the law and facts relating to the case; and, finally, the jurors, rendered thoroughly familiar with all the points in dispute, and acting independently, render the verdict: and they are better able to do this intelligently than they would have been if there had been *no* discussion.

It is evident also that the supposed evils are not limited to one, but that they extend in an equal degree to all other classes of expert testimony.

Those who are of opinion that the evil is actual and serious have from time to time suggested various remedies.

It has been suggested that experts should be appointed as advisers to the courts, by the State or municipal governments.

Against this method lies the grave objection that the public can have no assurance that the best men would be chosen. The appointing power might be influenced by personal or political motives, rather than by the acknowledged fitness of the person chosen; and it could provide for experts in only one class of cases, since no man could be an expert in all cases in which his services were required.

If it is proposed that the courts should themselves, as occasion might arise, make the appointments, the method would still be liable to the objection that even the courts could not always be relied upon not to make choice of improper men, either because they were uninformed, or entertained personal friendships.

To a certain extent, in cases where the ends of justice plainly demand the exercise of this authority, the courts, or the attorneys who officially represent the courts or the Government, are, under existing laws, permitted to summon expert witnesses; and, in the narrow limits within which this power is now authorized and exercised, it can do no harm. It is only against the exercise of this authority as an exclusive or even general mode of obtaining expert medical testimony, that I desire to record my protest.

In whomsoever the power to make these appointments may be vested, and in whatever manner it may be exercised, and whether the experts may be subject to cross-examination or not, in either case it seems to me liable to work injustice. It happens often that the accused comes into court under the imputation of a verdict of the coroner's jury, and under the adverse influence—more or less—of a presentment or indictment of a grand jury, both of which may be, and usually are, based upon *ex parte* testimony. The State or district attorney is

the representative of these preliminary courts in the prosecution of the accused, and he has already prejudged the case.

It would seem that the State has—in these manifest advantages—all the *ex parte* aid to which it is entitled, or which the ends of justice demand; but if we now add the testimony of an expert, perhaps not subject to a cross-examination, who has received his appointment from the State or court, and the opinions of the expert chance to be adverse to the accused, the latter enters upon his defense with the additional disadvantage of his case being probably prejudged by the court as well. Thus heavily handicapped, his chance of making a successful defense must be very small indeed.

This method of securing expert testimony seems to me also contrary to the spirit and genius of our institutions, but in harmony with the institutions of the greater part of Europe, where the tendency of governments to concentrate power in themselves, and in the courts, as instruments of the governments, is known and admitted.

In our system of jurisprudence and, I may say, in the Anglo-American system, the personal rights of the citizen are as carefully guarded as those of the State. In the present case the State has certainly its equal share of protection, and by the proposed change it would have more than its just share.

I make no reference to the other means provided by the State for the determination of questions of insanity, such as commissioners in lunacy, etc., because they are in no way connected with the matter now under consideration, namely, the proper method of securing testimony in courts of law.

During my temporary residence in Paris, in 1844, it was a matter of common remark, among medical men and medical students, that Orfila, the celebrated chemist, and the official adviser of the crown in certain matters of expert testimony, had committed a great blunder in a recent case of supposed poisoning by arsenic, and that the error had been detected and exposed by a member of the Academy of Medicine, but that the disclosure of the error came too late to remedy the injustice and harm it had done. He was charged with having been the instrument of like injustice to others, and was frequently spoken of as the "king's executioner."

I do not relate this as reliable history, but only as my recollection of the common gossip of the day; but, whether the accusations were true or not, they were plainly such as might reasonably be made and justified under a system of jurisprudence in which the professional expert is an appointee of the crown, and is regarded in the light of an official adviser.

In some cases which have come to my knowledge the public has seemed to form its opinion as to the nature and value of the expert testimony solely from the verdict rendered by the jury. In the case of The People against Cole, tried at Albany in 1868, Judge Hogeboom

presiding, the jury rendered a verdict of acquittal on the ground of unsound mind; but no medical expert had testified that Cole was insane. In the course of my examination as an expert witness, the court asked me whether I thought "that Cole, at the time he committed the act for which he was under trial, knew the difference between right and wrong, and that the act was in violation of the law." To which I replied in effect that "Cole, being suddenly confronted by the man who had wronged him, did not probably consider whether the act which he was about to commit was in violation of the law or not." If the jury made use of this reply to pronounce him insane, the responsibility of their verdict does not rest upon me. Their verdict of "unsound mind" was given, as it has been in many similar cases, because they did not think he ought to be punished for the act, and they were quite willing to give a very broad and partial interpretation to any testimony which in the remotest degree seemed to favor the defense. Subsequently, from several sources, I learned that my testimony, inferred only from the verdict, had been subjected to criticism.

The question put to me by the judge, although not so broad as it is usually made, no doubt had in view the legal definition or tests of unsound mind, and which, with a few slight modifications, has been incorporated into most systems of jurisprudence. But no legal definition of unsound mind can ever be properly made; and for the simple reason that no scientific definition is possible. The latter fact has generally been admitted by writers upon mental disease; but, nevertheless, they have often attempted to make what they are pleased to term approximate definitions, for the purpose, as they have declared, of furnishing at least a guide in the proper direction. Upon these approximate definitions the law-makers have constructed their legal definitions or tests; no longer intended as guides simply, but as authoritative and sharply defined distinctions, which the courts are compelled to recognize. Whether these tests be applied in a scientific or legal sense, they are in my opinion unsound, unjust, and confusing; they are calculated to mislead the judgment rather than to direct it to a proper conclusion. They ought, therefore, to be abandoned, and the whole matter left to the common sense of the jurors, aided and enlightened by the testimony, the arguments of the counsel, and the exposition of the courts.

4. While, in what I have said, I trust I have shown a purpose to defend my professional brethren, when appearing in the *rôle* of experts in lunacy, against unjust criticism, by maintaining the undeniable proposition that, other things being equal, they are the most trustworthy witnesses, I am at the same time prepared to say that they are not the only persons or classes of persons whose opinions as experts may be valuable in matters of this sort, or whose opinions might not, in some cases, be safely substituted for their own.

In reference to questions of sanity or insanity, most men of intelli-

gence who have reached adult life are experts. It is, with all of us, the daily practice of our lives to observe and study men's conduct and motives, and we are quick to discover the smallest evidence of mental unsoundness, especially in those with whom we have intimate personal acquaintance. Indeed, in most cases the mental alienation is suspected, or well known, long before the case is brought under the notice of the alienist.

It is not the same, however, in reference to most other subjects in which the services of experts are demanded. It is not so in most matters pertaining to either science, art, commerce, or the general business of life; in all of which the average citizen is presumably without experience or knowledge, and without the aid of the expert he could not intelligently perform the duties of a judge or of a juror.

If the question involved were one of mineral or vegetable poisoning, the trial of the case without the assistance of a practical chemist would deservedly expose the court and the law to public contempt.

If, again, it were a question whether the neck of the thigh-bone had been broken within or without the capsule, involving, as this question does, in a great measure, the degree of permanent injury which the patient has sustained, without the aid of an experienced surgeon it would be impossible to place the case fairly before a jury, not one of whom, probably, had ever seen either accident, or knew that they were not identical.

Finally, there is reason to fear that in one direction professed alienists are more liable to err than most other men of learning and experience, but who have not confined their studies so exclusively to the specialty of mental diseases.

It is a fact of common observation that, in all departments of medical science, the specialists to whom our science is indebted for some of its most important improvements and discoveries, are inclined to extend the range or number of diseases and of sympathies referable to the organs of whose lesions they have made a special study. This they do conscientiously, sometimes wisely and sometimes unwisely—their errors being exposed when some other specialist traces the functional disturbance to a lesion of some other organ, or the general practitioner demonstrates that all or nearly all the organs of the body are suffering from a general dyscrasy, and that the lesion of no one in particular can fairly be held responsible for the particular symptoms in reference to the cause and treatment of which the specialist is consulted.

Alienists need to be reminded that they have shown the same tendency to increase the number of diseases under the title of insanity, and to widen the range of their specialty, by including a great many eccentricities and moral obliquities under this title; and that by so doing they have virtually relieved the subjects of these peculiarities

from responsibility. This is seen in the adoption of the terms monomania, moral insanity, insane impulse, insane delusion, and in the additions made from time to time by writers to the varieties of monomania, among which are placed kleptomania, pyromania, erotomania, theomania, dipsomania, homicidal mania, suicidal mania, etc.

Spitzka, in his recent treatise on "Insanity," which work has at once taken rank among the highest authorities upon this subject, speaking of monomania, says: "Here those alienists who delighted in burdening the infant science of psychiatry with new systems of classification, found a fruitful field for innovation. Whatever the direction in which a lunatic manifested his most prominent symptoms, that direction determined the coining of a new term. . . . The designations 'Gamomania,' or 'the insane desire to marry,' or 'Frauenschuhstehl-monomanie,' or 'the mania for stealing women's shoes,' are imperishable monuments of this folly." To which judicious remarks I will add that, if such acts or mental conditions are to constitute a basis for the classification of insanity, I see no reason why it should not extend to every faculty, sentiment, or emotion of the mind, and to every act of eccentricity or of viciousness which disfigures human conduct.

Rush, the author of "Medical Inquiries and Observations on the Diseases of the Mind," has been quoted as having said that all men were insane on some subject. To the same conclusion it would seem that certain alienists are inclining. If this be true, then the whole matter we have been considering becomes greatly simplified. All men are insane, and all are irresponsible.

It would be unjust to Dr. Spitzka, in whose opinions I have expressed a concurrence, as well as to myself, if I did not state that Dr. Spitzka is willing to retain the name monomania when the use of the term is accompanied with certain reservations and restrictions, "with the limitation that the prefix shall be understood to denote that the insanity extends in a special direction across the mental horizon." He justifies the continued use of the term, but not its abuse.

It is upon this point alone that our opinions diverge. I can not think it advisable to retain the term monomania, or any of the subordinate terms, either for purposes of classification or for the convenience of clinical description. Most alienists are agreed that, even when they use these terms for classification, they do not mean to say that the subject is insane upon only one point, but this is exactly what the term means, if it means anything. It is true that different alienists offer different explanations or definitions of the term, but nearly all admit that it does not mean insanity upon a single subject; and every one must have seen that, with or without explanations, the use of this term by writers and by expert witnesses renders it difficult, if not impossible, for the reader, the public, or the jury to distinguish in many cases between acts of moral obliquity, eccentricity, or viciousness on the one hand, and actual insanity on the other; between responsibility

and irresponsibility. By the multiplication of terms of uncertain meaning they have darkened counsel.

It is liable also, in my opinion, to the further serious objection that it influences, unconsciously but perceptibly, certain alienists to extend unreasonably the limits of the term insanity. I am at least certain that, in this regard, it works mischief in its influence upon the people at large, among whom the word kleptomania and other analogous terms introduced by writers upon mental diseases are in common use, and by whom in most cases they are employed as an apology for crime. I would prefer, therefore, when a man steals and his conduct in other matters shows that he is of unsound mind, that he should be called insane, and not a kleptomaniac; but if he steals, even where the motive may not be apparent, and in all other respects his conduct is consistent, and his mind appears sound, it would be better both for the interests of science and of society that he be called a thief.

HOW FUNGI LIVE IN WINTER.

By BYRON D. HALSTED, Sc. D.

"HARD times" come to most living things. Plants as well as animals have periods when they need to conserve all their energies, husband all their vitality. All vegetation obeys the injunction to multiply and replenish the earth, but with the greatest determination when there are present suffering and impending death. A drought hastens the processes of reproduction, and insufficient nourishment encourages an early if not an abundant fruitfulness. In a climate where hot and cold, or wet and dry, seasons regularly succeed each other, many of our most common economic plants have adapted themselves to these stated changes of outward conditions, and run their course during a single growing season. Such plants constitute that large portion of our vegetation known as the annuals. The great sunflower, that grows into a giant in a single season and defies the summer sun and storm, falls an easy victim to the frosts of autumn. It, however, prepared the way for many successors, in the ripened seeds, each one of which when given favorable conditions will germinate, grow, reproduce its kind, and thus finish another cycle in the realm of vegetable life. The bean-plant, in a different way, climbs its appointed pole, enjoys the same sunshine and shower, produces its blossoms, fills long pods with ripened seeds, and gives up its life like all its fellows in the field. A corn-plant completes its growth in not far from a hundred days, and leaves its accumulated vitality stored up in the grains upon the ear. The prospective life and activity of a whole field of waving corn may be considered as stored up in a few

pecks of apparently lifeless seed-corn safely housed in the granary. We thus see that in the annual plants the life of the species is, so to speak, carried over from one growing season to another in the ripened seed. The seed is also the form in which plant-life is easily transported from place to place. The seed of some hedgerow weed, as it becomes loosened from its attachment upon the lifeless mother-plant, and is blown for rods or even miles over the surface of the incrusted snow, is a familiar and perhaps striking example that may enforce the meaning to be here conveyed. The young plantlet in the seed, snugly packed within thick coats, is preserved from death, and at the same time is carried far from the place where it was produced. The seed is the offspring of the plant and the childhood of its kind, though so fashioned and protected that it can pass safely through a period of drought or cold when its parent would have succumbed. It is the motile or migratory state of plants, and many are the means of transportation by land, wind, wave, stream, passing herd, and flying bird, that are within its reach.

Biennial plants, like the beet, carrot, etc., spend one season in preparing for the coming days of inactivity and exposure, and close their careers the following year by using up the accumulated store of food in the roots, stems, or leaves, in producing a crop of seeds. These plants have taken one bold step toward that perennial condition of life enjoyed by our shrubs, trees, and many other plants. Even the "giants of the forest" prepare themselves for the trying months of winter; by withdrawing their vital fluid from the delicate leaves, and with apparently lifeless branches bearing buds enwrapped in scales and secured with a natural glue, they brave the winter blasts.

The season of growth is constantly anticipating the days when the streams of vitality must be checked. The gardener may remove his tender plants to a place "under glass," and so change the order of Nature that things get "out of season," but soon the tortured plants must have rest from their labors and an opportunity to reproduce their kind.

With this somewhat lengthy introduction to our subject let us enter a less familiar field of plant-life, and see if we do not find the same rule holding true among the minute and frequently very troublesome plants known as Fungi. Enough is not known of the habits of these low forms of vegetation for us to measure the natural limits of individual existence; in fact, individuality is very obscure, and, being largely creatures of circumstance, multiplication is extremely rapid when conditions are most favorable, and at a standstill when the reverse is true. Some of the simplest forms of this vast group, like the minute bacteria, yeast-cells, etc., pass through many generations in a few hours; while, on the other hand, the larger species of the hard, woody "shelf" fungi, on trunks of trees and old stumps, may represent in a single so-called "individual" the accumulated growths of a score or more of years. The mildews, molds, and fungi of that

description are popularly considered as very transient, and as frequently lasting for only a day. They start from a simple body called a spore, produce a network of fine threads, yield a crop of spores in a few hours, and the cycle of life is completed. We, however, find that this round of multiplication is varied, and even these evanescent mildews produce structures which serve the special purpose of carrying the species over trying times of starvation, drought, or cold. The common bread-mold (*Mucor stolonifer*), for example, so abundant upon stale viands in warm, moist weather, forms spore-bearing capsules upon the tips of perpendicular threads, which, when ripe, burst, and the multitudes of minute spores are scattered in all directions by every passing breeze. As the bread begins to get dry, and fails to yield a full supply of nourishmer mold commences to develop a second form of spore. These s iced by the union of the contents of two filaments (conjug wn in Fig. 1. The two Indian-club-shaped branches are end to end, at *a* and *b*; the union is

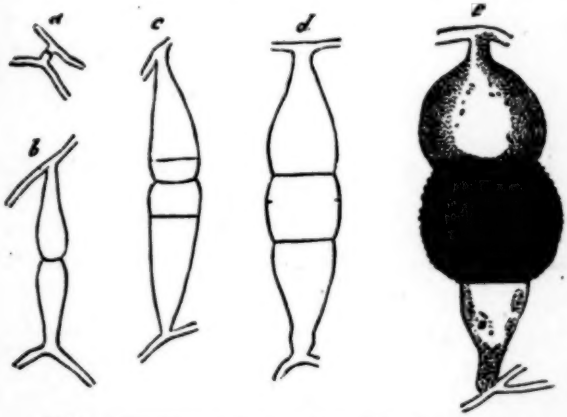
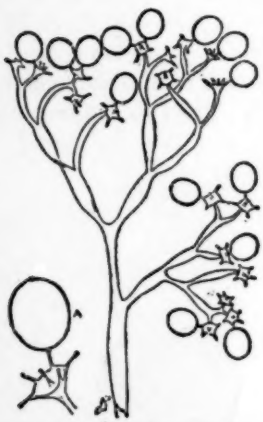


FIG. 1.—FORMATION OF RESTING SPORES OF BREAD-MOLD.

more advanced at *c*, while at *d* a central cell has formed, containing the mingled contents of the two united cells. At *e* is seen the mature spore, which has a thick, hard, black, and spiny covering, well adapted to protect its highly vitalized contents from all injury. This spore, though magnified ninety times in the engraving, is very much larger than the exceedingly minute sacs of protoplasm formed in the capsules above mentioned. The latter germinate at once, when favorably situated, but the larger black spore remains dormant for a considerable time. Rapid reproduction is provided for in the multitudes of small summer spores, while the preservation of the species is the end sought in the formation of the thick-coated black spores.

Passing from the minute molds that thrive upon bread, cake, etc., we come next to those parasitic species of fungi growing in the tissues of higher forms of plants. The grape-mildew (*Peronospora viticola*)

is a familiar destructive fungus pest that will serve our purpose in an attempt to show the preparation these low forms of plant-life make for passing over hard times, including the winter season. In early summer the lower surface of affected grape-leaves is covered with a minute forest of white filaments. The threads of the fungus run in all directions through the tissue of the leaf, and, coming to the surface, pass through the breathing-pores of the epidermis, and afterward branch and bear oval spores on the tips of the filaments. Fig. 2 represents a small portion of a branch of the lettuce-mildew, which is in the same genus, and closely related to the mildew of the grape. The branch is magnified two hundred times, and the spore A and its attachment are enlarged five hundred diameters. The multitudes of spores borne upon the tips of the branches are for



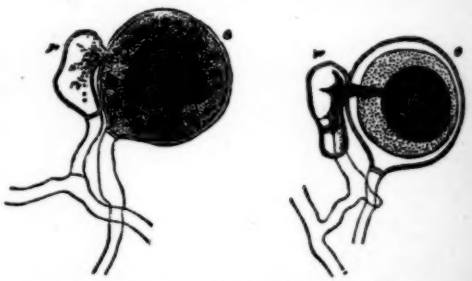


FIG. 2.—BRANCH OF LETTUCE-MILDEW. FIG. 3.—FORMATION OF GRAPE-MILDEW, WINTER SPORE.

the rapid propagation of the mildew. They germinate by producing zoöspores—that is, the contents divide into six or more oval bodies, which soon rupture the spore-wall and escape, each provided with two hair-like appendages termed cilia. These motile zoöspores reproduce the mildew in a new place upon the same or another grape-leaf. Later in the season, and within the substance of the leaf or fruit, a second form of spore is found. This is termed a sexual spore, and requires the union of the contents of two peronospora filaments for its production. One of the thread-tips becomes much enlarged, as shown in Fig. 3, *o* (on the left), which represents the female cell charged with granular protoplasm. Another thread, *n*, arises near by, becomes club-shaped, and applies itself to one side of the female sphere. The contents of the male cell enter and mingle with those of the female, after which the latter matures into a spore. The process of fertilization is further shown in the portion of the engraving on the right, all parts being magnified three hundred and fifty times. The dark central portion is the spore, the contents of which become securely protected by the thick, hard coverings. Unlike the small, thin-walled spores borne upon the tips of the aërial branches, these large sexual spores remain through the winter before germinating. The vitality of the grape-mildew is

concentrated and protected, thus enabling the fungus to survive an exposure that might otherwise prove fatal. It should also be kept in mind that the substance of the leaf in which these spores are imbedded aids in shielding them from harm. If the vineyardist could destroy all these sexual spores at the end of the growing season, he would have little further trouble from the destructive mildew.

The members of the *Cruciferæ*, or cabbage family of plants, are quite generally attacked by white molds—so called because they cover the affected parts with a coating of almost pure white. A much magnified (four hundred times) view of the non-sexual spores is seen in Fig. 4. The white spores are produced in rows, forming be-

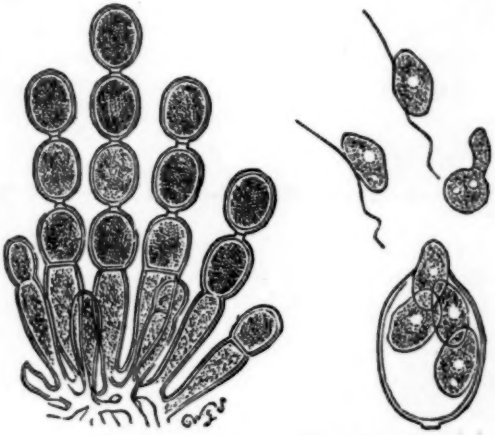


FIG. 4.—SUMMER SPORES OF WHITE MOLDS.

low and falling away from the top, in the simplest possible manner. The contents of the spores divide in germination as in the grape-mildew above described. A ruptured spore is shown one thousand times magnified, in the lower right-hand corner of the figure, while the ciliated protoplasmic bodies (zoöspores) are seen above. These white molds are provided with sexual winter spores very similar to those described for the grape-mildew; in fact, the two groups are closely related, and belong to the same family of fungi. Fig. 5 shows the mature sexual spores of *Cystopus candidus*, magnified four hundred diameters, one of which has its hard shell ruptured and its contents of zoöspores escaping. It requires weeks and even months for the development of these sexual spores, and frequently a long time may elapse before germination takes place. On this account they have received the very appropriate name of resting-spores. They remain within the tissue of the plant, and are frequently liberated only by its decay. The life of the white molds passes over from one season to another in these rough, thick-coated spheres of protoplasm, the formation of which approaches in complexity that of the seeds of higher plants.

The various rusts and brown mildews furnish very complicated methods of propagation, there being no less than four kinds of spores

FIG. 5.—SEXUAL SPORES OF WHITE MOLDS.

FIG. 6.—BARBERRY LEAVES WITH "CLUSTER-CUPS."

produced before the whole life-history of some species is complete. Beginning with the cluster-cup form, found abundantly on the barberry-leaves, as shown in Fig. 6, it is known that the spores from these "cups" produce the common rust upon the wheat leaves and stems. Later in the season another form of spore is formed in the same ruptured patches before occupied by the orange-rust spores. These last spores are double, and form slowly on the tips of slender filaments. Fig. 7 represents a cross-section through a pustule of brown mildew, two hundred times magnified, with the spores congregated beneath the ruptured epidermis. These dark patches and streaks remain until spring. When the spores germinate, as shown in Fig. 8, magnified five hundred times, each twin-spore sends out a filament that bears from three to five small oval bodies, known as *sporidia*. These will germinate on the barberry-leaf and develop the cluster-cups with which we started. It is seen that the rust has ample means for a

FIG. 7.—SECTION OF BROWN MILDEW PUSTULE.

FIG. 8.—WINTER SPORES OF BROWN MILDEW GERMINATING.

rapid propagation of its kind during the growing season, and finally stores up its vitality in dark, thick-coated spores that remain on the stubble through the winter, and are not injured by sudden and severe changes in the weather.

It is due the reader, in passing, to state that one or more of the four forms of spores here briefly mentioned may be omitted. In warm climates it is possible for the winter spores to be dispensed with, the ordinary rust-spores being able to remain alive and continue the life of the pest. It is also believed that in regions unknown to the barberry the cluster-cup form may also be omitted. Like all other living things, the rusts accommodate themselves to circumstances, though watchful that their members do not decrease from any lack of vigilance on the part of these parasites.

The order *Perisporiaceæ* illustrates our subject still further. The members of this group of fungi are mainly parasites upon higher plants, forming a whitish, web-like film over the surface of the affected parts. In the early life of these white mildews, the horizontal threads send up vertical filaments in which partitions rapidly form at regular intervals. The cells thus produced are spores which fall away in succession from the top. A single vertical filament is shown at I, Fig. 9.

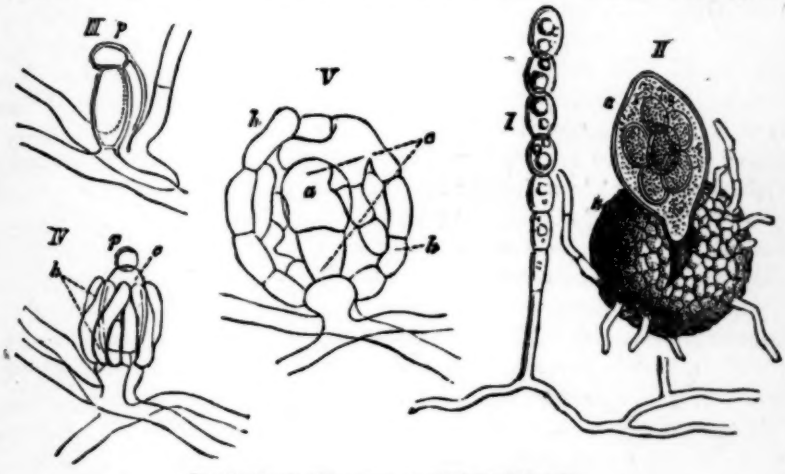


Fig. 9.—Spore Formation of White Mildews.

The spores thus produced are minute, the winds easily disperse them, and they quickly germinate, giving rise to new filaments of mildew. The formation of the sexual or winter spores begins late in the season and is shown in the remaining portions of the engraving. When these spores are to be formed, two filaments, crossing each other as shown at III, send out short projections. One of these, *c*, becomes the female part, and the other, *b*, the male portion. As a result of fertilization, eight or more branches, IV, *h*, grow up from the base and envelop the female cell. These branches continue to grow until a thick, hard cov-

ering is formed. This spore-case is shown more advanced in V. Within, one or more sacs containing spores are formed. At II is seen a mature spore-case which has been ruptured and a sac containing five spores has nearly escaped. It is seen at a glance that the provision made by these species of fungi for the protection of its spores during winter is most complete. Each spore is, doubtless, surcharged with vitality; around it is a sac, and outside of this a thick, hard covering not easily broken. Many of these spore-cases are provided with hooked appendages, by means of which they may hold fast to rough surfaces, and thus the contents are further protected.

The black-knot (*Sphæria morbosa*), so injurious to the plum and cherry trees, furnishes an illustration of another family of fungi, many members of which are considered as perennial. The fungus attacks the young branches, causing them to swell to several times their natural size. The enlarged portion of the branch is made up of a vast number of minute threads, which increase in length and size until the bark of the twig is ruptured in one or more places. An olive-green covering soon forms over the exposed part, consisting of spores borne singly upon the tips of fungus-threads. These simple reproductive bodies quickly pass away and spread the disease to other parts. Later in the season the knot becomes incrusted and a second form of spore is produced, very different in form from the simple oval ones already mentioned. As autumn approaches, the knot assumes a black and rough appearance, indicated in Fig. 10. In the hard crust small pits are formed, in which spores are slowly produced within long, slender sacs. These spores are not ripe until toward spring. In this well-named black-knot we have a fungus with at least three forms of spores, one of which serves the important purpose of carrying the species through the winter season, in a form admitting of a ready dispersion in the early spring. The knots last for more than one season, thus showing that the whole community of fungus-life on a single plum or cherry branch is perennial. This is well shown when a gardener fails to cut away the branch for a sufficient distance below the affected part, in which case the remaining end will develop into a well-formed knot the following season. The filaments of the fungus extend for a foot or more below the swelling, and live on from year to year.

Belonging to the same great group of fungi with the black-knot, but furnishing a different illustration of our subject, is ergot (*Claviceps purpurea*). This fungus attacks the young female portion of the flower of many grasses, and replaces the grain with a hard, irregular mass, several times the size of the unaffected grain. From the resemblance of these grains to the spurs of a cock, and because they are most abundant upon the rye, the fungus has received the common name of "spurred rye." Fig. 11 shows a head of rye, natural size, with four of its grains ergoted. Multitudes of minute spores are produced upon the surface of the affected grain during the growing sea-

son. These, as the reader will naturally infer, are for the rapid propagation of the ergot elsewhere. Usually nothing further in spore-formation takes place until the following spring. The hard, purplish ergot-grains contain no spores, being simply indurated masses of threads containing a very large per cent of oil. This is the winter condition of the fungus. With the warmth of spring and the moisture of the soil upon which the grains may be lying, the horny spurs soften and send out stalks from one or more sides, which have club-shaped extremities bearing multitudes of long, slender spores in minute, pear-shaped sacs. Fig. 12 shows a "growing" ergot-grain in the upper left-hand corner; a cross-section of a head below; a more highly magnified view of a

FIG. 10.—A BLACK KNOT.

FIG. 11.—ERGOTED RYE.

pit on the right, and near the center of the engraving is a single spore-case with the needle-like spores protruding.

The ergot is not alone in assuming a hard condition for the purpose of getting over a severe period of either cold or drought. The term *sclerotia*, meaning *hard*, has long been employed as a name for the compact, resting condition common to many fungi. In the early history of this group of plants, *Sclerotium* was the name of a prominent genus abounding in many so-called species. Now, of course, this

genus has passed away, because founded upon a single condition which any species may assume for self-preservation. The fine threads of various toadstools frequently become joined in long, hard masses, and may be found at the base of almost any decaying stump. It is not unreasonable to suppose that a fungus, otherwise short-lived, may survive the trying circumstances of heat and cold for a score or more of years in this hibernating state.

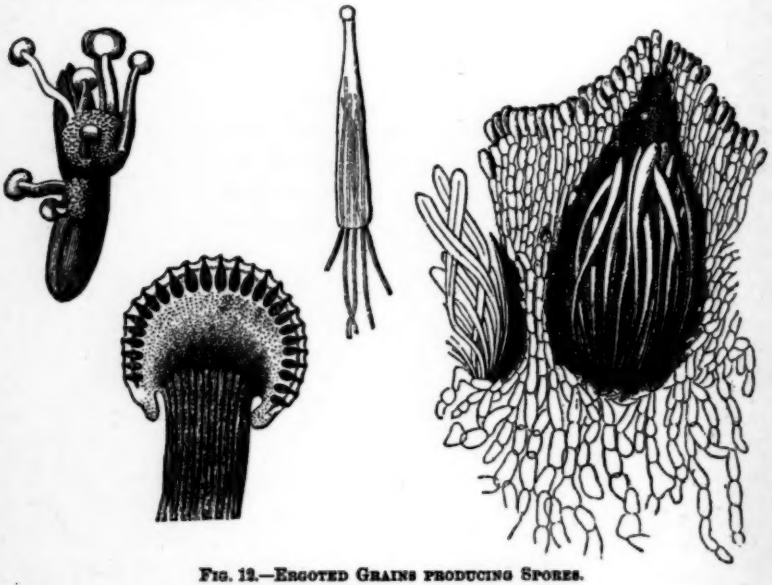


FIG. 12.—ERGOTED GRAINS PRODUCING SPORES.

The spawn of the common mushroom is a familiar example, to many, of the apparently lifeless condition which the threads of a fungus may assume. This spawn, consisting of the dried filaments of the mushroom, is sold in bricks, and afterward placed in beds which supply the proper heat, moisture, and nourishment for the growth of the edible mushrooms. Yeast, representing the smaller kinds of fungi, can also be kept in dried cakes, ready at an hour's notice to spring into activity and make our bread light and wholesome. It would be interesting to descend lower in the scale of plant organization (if it is lower), and see even among the bacteria, now brought so prominently before the world by the labors of Pasteur and Koch, that these minute organisms, after exhausting the nourishment from a liquid, form a precipitate, which may be regarded as a resting state. Enough, however, has been given to show that fungi, though a humble group of plants, do not lack for methods of rapid increase when favorable conditions prevail, and have abundant means for sustaining life during periods when growth is impossible.*

* The cuts used in this article are re-engraved from Smith's "Diseases of Plants," Bessey's "Botany for High Schools and Colleges," and the Bussey "Bulletin."

CHOLERA.*

By Dr. MAX VON PETTENKOFER.

II. MODES OF PROPAGATION.

HAVING now discussed the relations in time and space which predispose to cholera, I shall pass on to consider those relations in regard to the freedom from cholera which they may enjoin. Places which enjoy an immunity from cholera are more numerous than was formerly supposed, but have been less studied from a point of view of epidemiology, just as relations in time have been but little investigated. The eye of the investigator has only fixed itself on the places where, and at the time when, cholera has reigned. We ought likewise to investigate the matter when and where cholera does not exist. Ordinarily a physician only bestirs himself when he is called to see a case. It has, however, not been so with me. Impressed with these notions, I went in 1868 to the place in Southern France which had enjoyed the greatest and most renowned immunity from cholera. Through the kindness of M. Fauvel, I was introduced to M. Luuyt, of Lyons. Although Lyons was in frequent communication with Marseilles and Paris when epidemics of cholera raged, yet the disease never showed itself in an epidemic form at Lyons. In 1849, for instance, Lyons was besieged, conquered, and invested by troops suffering from cholera. Then the town escaped, while the soldiers suffered severely. This immunity was certainly not due to greater cleanliness of that quarter of the town known as Croix Rousse; nor was it due to the social misery or to the wants of the working-classes; neither had the drainage or water-supply, which prior to 1858 was as bad as it could be, anything to do in the matter. So that the immunity was probably the result of natural conditions. The Lyonese had often congratulated themselves on this excellent gift of nature, but it is probable that the constant movement of air which the combined flow of two great rivers (the Rhône and the Saône) originate is the cause of the immunity, although the mistral (*Mistralstürme*) which scours Languedoc and Marseilles had never been able to drive the cholera away. The situation of Lyons is far different: the bed of the two rivers is composed of compact granite, which on the right bank of the Rhône and on both banks of the Saône rises high, being in places coated with lias, molasse, and thick mud strata. On the heights lie the parts of the town called Croix Rousse, Fourvière, and St. Juste; other quarters lie low—Perroche on a tongue of land between the two rivers, Lyon Vaise on the right bank of the Saône, and Brotteaux and Guillotière on the alluvial soil of the left bank of the Rhône. The lower parts of Lyons

* Reprint of a special translation made for the London "Lancet."

are frequently and deeply flooded over, and yet the cholera never comes!

Just as the disposition to cholera in time and place may be due to two causes, so may the immunity from cholera be dependent either on the physical nature of the soil, as is the case in parts of Traunstein and Kienberg, or on the condition of the soil as regards moisture, as happened in the low-lying parts of Munich during the summer epidemic of 1873, or at Augsburg during the summer and winter of 1873, or at Munich in 1866. Such a degree of wetness as prevailed on those occasions may be a constant condition in some places; to this latter group the low-lying districts of Lyons belong. Indeed, both factors are at work in Lyons. In the high-lying parts the granite comes to the surface in many parts, and so a very efficient and natural drainage is secured. These districts may always be said to be free from cholera. The soil of the low-lying parts, situated on the banks of the Rhône, Brotteaux, Guillotière, and Perroche, has always a certain degree of humidity, which cholera when imported has to encounter. This moisture of the soil of parts of Lyons is dependent not only on rain, but also on the river Rhône. The impermeable bottom of its bed is of solid granite, to which fact I could bear personal testimony. This stratum of granite stretches from the left bank of the Rhône far inward, so that Lyons is built upon it; all the springs lie below the level of the surface of the waters of the Rhône, and so rise and fall with the river. In Paris, in Munich, and in Berlin the conditions are otherwise. Here the level of the subsoil water is above the level of the waters of the Seine, Isar, and Spree, respectively; this relation is the most general, so that Lyons is exceptional. In Lyons it may be said that a part of the Rhône runs subterraneously, so that the soil receives water from the river; whereas in Paris, Munich, and Berlin the direction of the water is constantly from the soil to the river. When the water rises in the beds of the Seine, Isar, and Spree, there is no penetration of the water into the porous soil, but rather a damming and stagnation in the discharge of the subsoil water. The granite of the Rhône, chiefly composed of large blocks of quartz, contains also much fine sand, which is able to suck up water to a considerable height in its capillary spaces, possibly as high as the zone of evaporation. I investigated the hardness and moisture of this quartz by actual digging. This part of Lyons is only at times free from cholera, and would be susceptible of an epidemic were some of its water taken away. That Lyons may be fatally visited was shown in the year of cholera, 1854. As I was studying the conditions of cholera in Lyons, I found that in 1854 no less than 500 deaths occurred from the disease; while at other times the town escaped with a dozen deaths. It also transpired that nearly three fourths of the deaths happened in Guillotière, and I must say, therefore, that in the year 1854 at least a part of Lyons suffered from an epidemic of cholera. The Lyonese were not pleased with this

assertion, because they had always boasted of their immunity from cholera; they replied: "What are 500 deaths out of a population of 400,000? It is absurd to call that an epidemic!" Of course, it would not be right to speak of an epidemic of all Lyons, but most assuredly there existed an epidemic in a part of it. The higher-lying districts had enjoyed their usual immunity in 1854. In the times of cholera which followed 1854 Lyons preserved its freedom. In what respect did 1854 differ from all other years? In nothing but in the fact of its greater dryness. I availed myself of the observations of the meteorological station, and found that in this year the amount of evaporation was greater than the rainfall. Observations on the subsoil water were not to be obtained, but there was the register of the condition of the Rhône dating as far back as 1826. From 1826 to 1854 there was no lower register so lasting as that of the last year. These facts were sufficient to lead me to understand how the lower-lying parts of Lyons could be brought into a condition susceptible of an epidemic of cholera by the partial or total removal of the influence of the Rhône.

That too much as well as too little water in the soil is unfavorable to cholera is vouched for by a large mass of facts. As I watched the cholera in Bavaria during 1854 I was surprised to find that the marshy districts, where, as a rule, the poorest dwelt, were exempt from epidemics. The great Donau bog, which lies between Neuburg and Ingolstadt, was surrounded by the epidemic, but the disease did not enter the villages on the fen. On the Freisinger moors an epidemic occurred at Halbergmoos. On going thither the affected houses were found to stand on a tongue of land composed of quartz, which tongue reached inward on the moor. Reinhard had proved the same thing for Saxony. The northern part of Saxony, which lies on the Spree, is a highly malarious district. For the eleventh time that cholera visited Saxony it shunned this region of fever. I will not say that cholera can not be epidemic on a fen, but I do believe that when such an occurrence takes place we ought to ask ourselves what relation it may have with the state of moisture of the soil. The theory on the soil and subsoil water requires that a knowledge should be obtained of what takes place in and over the soil on the outbreak and on the cessation of cholera. It requires, as Port has said, a continuous record of facts. That cholera should very seldom be met with in the neighborhood of and on mountains is also in harmony with the disposition of cholera in respect of time; so that, as the frequency of cholera in these regions diminishes, the rainfall increases; the weather and cholera are equally capricious. Towns among mountains which are refuges for fugitives from cholera are but seldom situated on a soil which in and of itself would exclude cholera. Salzburg and Innsbrück have, for example, never yet been visited by cholera. Further, in 1866, these towns escaped, although a considerable influx took place from the seat of war where cholera raged. Salzburg, but still more Innsbrück, stands on

the alluvial soil of the Salzbach and the Inn, as Munich stands on the Isar; but the first-named towns have about fifty per cent more rainfall than Munich. I can only imagine that the necessary degree of dryness for the development of cholera would be attained but very rarely in Salzburg and Innsbrück, just as occurred partially at Lyons in 1854, and in June, 1859, at Bombay, where cholera prevailed during the monsoons, which, as a rule, drive the cholera away.

The disposition of cholera in regard to time is also evidenced in the fact that the disease is so different in one and the same place at different times, or at like times in one and the same place, if different parts of the place have different kinds of soil. For instance, in Munich the houses situated on the clay ridge of the suburb of Haidhausen are never affected, but this exemption is certainly not due to the supposed prevention which clay soil in and of itself exerts against the development of the germs of cholera, but because the behavior of rain on clay and rocky soil is very different if the rain be equally distributed over the two kinds of soil. When the rocky soil at Munich was ready for cholera, the clay soil was not.

I shall now leave the arguments for the localists, and pass on to consider the circumstances which are favorable to the views of the contagionists.

That an epidemic of cholera does not permanently last in one place, but after a longer or shorter time ceases, is explained by the contagionists as due to the saturation of the population, whereby each individual acquires a protective influence against cholera similar to that acquired after vaccination as against small-pox and other like instances. This hypothesis does not explain why an epidemic is sometimes rapid and sometimes slow in its course, why it is sometimes vast in its ravages and at other times slight in its effects, while the condition of mankind remains practically the same. With as much reason might the localists assert that the germs of cholera find at different times the local conditions to be favorable or unfavorable with the natural consequences of growth or death. Now, in districts where cholera is endemic, as in the soil of Lower Bengal, it is easy to suppose that at one time the conditions for the multiplication of the germs are present, while at another time the opposite state prevails. The dormant condition of the germs must, for a limited time, frequently exist in districts outside India. This supposition will not explain the occurrence in the low-lying parts of Munich of the severe winter epidemic of 1873–74, after the summer epidemic in the higher parts of the town had ceased. It follows that we must suppose that the germs which give rise to an epidemic may arrive at a place and there exist for some time (in Munich for three months) without showing any manifestations; and that, indeed, the germs may die before the necessary local conditions for their growth and multiplication are present. So that one might seek in vain to trace the connection between cases of cholera coming

from without and the first cases of illness occurring in a place, as happened in 1883 at Damietta in Egypt, and in 1884 at Toulon in France. The germs may have arrived six months before without finding the necessary material for their growth, and consequently may die out before giving any signs of their existence.

How long the germs of cholera may remain latent in a place we have no evidence to show. There are cases in which we might say that a whole year elapses, but instead of that I think it can be shown that in Europe the germs die out. Since cholera has lasted for many years in Russia, some epidemiologists have supposed that in Russia in the North, just as in Lower Bengal in the South, cholera is endemic. The history of cholera, however, in two islands of the Mediterranean, Malta and Gozo, supplies an example to the effect that the germs of cholera may die out in the space of a few years, and that the germs must be again imported before fresh cases of Asiatic cholera can appear. The Islands of Malta and Gozo lie near one another, and are by nature so similar that it might be imagined that a single homogeneous rock had been split into two parts, a greater and a smaller, which lie as near together as possible in the water without touching one another. It is thus that the two islands project from the sea. Each has the same kind of soil, enjoys the same winds, the same sunshine and rain, the same population of Arabic origin, with like manners, customs, and daily intercourse. Vegetables, fruit, and cattle for slaughter pass daily from Gozo to Malta. The two islands differ in that Gozo has no direct intercourse with the world at large, while Malta is famous for its natural harbor. Both islands have experienced epidemics of cholera, but Malta was always invaded some weeks before Gozo. Finally, both islands show themselves equally susceptible to cholera. In 1865 in Malta 12 per 1,000 of the population, and in Gozo 10 per 1,000, died of cholera. The first case of cholera occurred in 1837 on May 26th in Malta, and on July 5th in Gozo; in 1850 it was June 9th and August 28th respectively. In 1854 and 1856, during the Crimean War, cases of cholera appeared in Malta and Gozo, but not in an epidemic form; nevertheless, sporadic cases first showed themselves in Malta. In the epidemic of 1865 the first case occurred in Malta on June 28th, and in Gozo on July 21st. This interval of time between Malta and Gozo makes me suspicious of the current doctrine that cholera can occur in places two days after the arrival of the infecting cases; for it has not been proved that cases might have arrived still earlier. The instance of Malta and Gozo clearly proves that cholera may have no long duration, that it is not autochthonic, that it is not brought by the wind, but that for its passage intercourse is necessary.

The facts of the influence of locality the contagionists can not deny; indeed, they accept the facts, but explain them in another way. Attempts are made to show by the localists and contagionists, how the germs of cholera spread by means of human intercourse may act

in harmony with the conditions of soil and subsoil water. This is unfortunately still the darkest chapter in the book, and will probably remain so; but it is not darker than the explanation of the nature of another infectious disease, which is equally dependent on conditions of soil and water—namely, malarial fever. We are firmly convinced of its telluric and climatic origin, and yet a study of Von Hirsch's "Handbook on Historio-Geographical Pathology" shows how little we know. Whether the infective material gets to man from the air, or water, or food, or the sting of a gnat, and so forth, we know not; and if we examine the tables showing the appearance of ague in the different months of the year in Leipsic, Vienna, etc., we come to see that the tables are not so very different from those drawn up by Brauser on cholera. In malarial fevers it is doubted whether infection is conveyed by the drinking-water, whereas contagionists believe that cholera is propagated through this source. The drinking-water theory played a great part in the causation of epidemics in the middle ages; it was believed that wicked men, either Jews or Christians, had poisoned the springs from which death was drunk. For good health, pure water is as necessary as pure air, good food, comfortable quarters, and so forth. I myself am an enthusiast in the matter of drinking-water, but not from fear of cholera or typhoid fever, but simply from a pure love for the good. For the water is not only a necessary article of food, but a real pleasure, which I prefer, and believe to be more healthful than good wine or good beer. When water fails, man may suffer not only from cholera, but from all possible diseases. In places where cholera prevails the water may always be indicted, for the water-supply is always a part of the locality, and the doctrine will frequently hold good, because the part may be mistaken for the whole. Where the influence of the water is held up to the exclusion of all other local factors error is liable to creep in. In England, where the drinking-water theory is fully believed in, two like influences, in which every other local factor was excluded, were observed in the cholera epidemic of 1854. In one case, in a street in London which was supplied by two water companies, the Lambeth with pure water, and the Vauxhall with impure water, it was found that the cholera was practically limited to the houses supplied by the Vauxhall Company. I was so much impressed by this fact that I endeavored to see whether the epidemic of 1854 in Munich could not be explained on a similar hypothesis. But my researches led me to a negative result. Without doubting the facts observed in London, I am of opinion that the impure water of the Vauxhall Company did not spread the germs of cholera, for the propagation of cholera was not effected by this means in Munich, but that the water increased either the personal predisposition to cholera, or perhaps the local predisposition, since the water would be employed in the houses, and about the soil. Later on, in 1866, Letheby doubted the accuracy of the drinking-water theory, and

proved that there had been considerable confusion; so that a house which was registered on the Lambeth Company, really drew its water-supply from the main of the Vauxhall Company, and *vice versa*. The cholera epidemic of 1866 was essentially limited to East London. The East London Water Company supplied this district with water filtered from the river Lea. Letheby brought forward a series of facts to prove that we might with equal justice accuse the East London Gas Company, since the first case of cholera broke out at the gas-factory. A second instance in London was that with which the name of Dr. Snow is associated. Golden Square, a part of London with very deficient drainage, was the scene of a severe epidemic of cholera in 1854. The epidemic concentrated itself in Broad Street. There must have been some reason for this, and the reason must be discovered. Where Golden Square and Broad Street stood was formerly a place of burial for individuals dead of the plague. This pest-blast of a former century could walk from its grave in A. D. 1854 like the ghost in "Hamlet." But a narrower inspection proved that the old pest-field and the new cholera-field were not exactly coextensive. Now, however, another fact was brought to light, which led to the substitution of the drinking-water as the cause. In the middle of Broad Street there stood a pump of which the water was much esteemed on account of its freshness. At the end of August, while the cholera was raging, it was found out that many sufferers had drunk of the pump-water, but the fact was not sufficiently decisive, and so a pathological experiment was required. In Broad Street there was a percussion-cap factory belonging to Mr. Eley. The persons of this establishment suffered from cholera, and many of them died. Mr. Eley remained well, but he did not live at the factory, though he went there daily and returned home to Hampstead after business, and there lived with his mother and a niece. His mother, who formerly lived in Broad Street, had a great liking for the water of the pump-well, which was shown in the fact that her son daily took home the water for his mother and niece. In Hampstead there had been no case of cholera until the mother and daughter fell ill and died of cholera, without having any other communication with Broad Street than through the means mentioned. What more is wanted? Who can doubt any longer? An experiment on two human beings with a disease which animals are not susceptible to! A sad privilege. Never before had facts received a more frivolous interpretation. Suppose, for a moment, that Mr. Eley had gone to and from Hampstead to Broad Street without having taken the water to his mother and niece; and, further, that they had become ill of the cholera without having drunk the pump-water, would it have been imagined that the cholera had been carried by the son, who remained in good health? The contagionists would probably reply that Mr. Eley may have had the cholera in a mild form. The localists would say that a poison locally originated might be passed on by healthy people without

giving signs of illness in them. In 1854, for example, a young lawyer went from Munich to Darmstadt, where his father resided. Up to that time the father had never lived out of Darmstadt, and Darmstadt was as free from cholera as Hampstead, and the distance from Munich was much greater than Hampstead from Broad Street. The lawyer was as well in health as Mr. Eley had been, but the lawyer's father fell ill and died of cholera. There was no other factor in the case than the return of the son from Munich. Darmstadt enjoyed an immunity from cholera as great as that of Lyons, Versailles, Stuttgart, and many other large cities. In 1854 a workman went home from the Exhibition of Munich to Darmstadt, where he fell ill and died of cholera without the disease being spread to any other house, and no means for disinfection or isolation had been adopted. In 1866 Prussian troops were quartered in Darmstadt, and brought the cholera with them. About thirty of the soldiers became ill with cholera, and many of them succumbed; again, none of the inhabitants of Darmstadt had the disease. It must be admitted that Mrs. Eley might have been infected through the intercommunication of her son, just as the lawyer's father had been, without the intervention of drinking-water. The argument in favor of the drinking-water theory rests on the fact that the cholera ceased when the supply of water was cut off; but no notice was taken of the great majority of cases in which the water-springs were not closed, and the supply of water not cut off, and yet the epidemics came to an end. Again, in Broad Street the pump-handle was not taken off till September 8th. Now, an examination of the facts will show that the cholera was already subsiding. In Broad Street, on August 31st, there were thirty-one cases of cholera; on September 1st, one hundred and thirty-one cases; on the 2d, one hundred and twenty-five; on the 3d, fifty-eight; on the 4th, fifty-two; on the 5th, twenty-six; on the 6th, twenty-eight; on the 7th, twenty-two; and on the 8th, fourteen. Just as occurs in India and elsewhere, a violent epidemic generally subsides rapidly.

The further one investigates the drinking-water theory the more and more improbable does it appear. Robert Koch, too, the famous bacteriologist, has hitherto failed to substantiate the drinking-water theory, and I feel convinced that the time is not far distant when he will own that he has gone in the wrong direction. Koch has succeeded in finding the comma bacillus in a water-tank in a region where cholera was prevalent. I have the greatest respect for this important discovery, not as a solution of the cholera question, but only as a very promising field for pathological, not epidemiological, inquiry. It must be remembered that cholera was already prevalent in the neighborhood of the water-tank from which Koch obtained the bacillus. Now, this tank was used not only for drinking purposes, but also for bathing the person and washing clothes, as Koch himself admits. According to my view the comma bacillus must have been present in the water. It

had not been shown, however, that the bacillus was in the water before the outbreak of cholera. Koch is of opinion that all the bacilli in the water-tank could not have come from the washing of clothes of cholera-patients, but must have partly been derived from multiplication, yet he forgets that, as he himself has shown, the meat-broth in which the bacilli grow must not be too dilute. It would have been interesting if Koch had estimated the strength of the nutritive material in the water-tank. But what chiefly contradicts the doctrines of the contagionists is the simultaneous disappearance of the cholera on land and the cholera bacillus in the water-tank. If it were really true that every case of cholera, the first as well as the last in an epidemic, had the same infective material in its intestinal discharge, and that the epidemic only ceased because the susceptibility of man had passed away, then the bacillus would continue to exist in the tank, always supposing that there was sufficient pabulum for it. And thus it is most probable that the bacillus gets into the tank from man, and not *vice versa*. While Koch was in Calcutta the English physicians there imbued him with their views on cholera and drinking-water. The English had been brought up on the drinking-water theory of typhoid fever and cholera, and could only lay it aside with difficulty. But a few of those English physicians who had studied wide-spread epidemics had renounced their original ideas. Dr. Bryden (the chief of the Statistical Department), Dr. J. M. Cuningham (the sanitary commissioner), Dr. John Macpherson (the Inspector-General of the Bengal Army), Dr. Lewis, and Dr. Douglas Cunningham were all disbelievers in the drinking-water theory. Koch was further strengthened in his views, in opposition to the few Englishmen just named, from the fact that after Fort William in Calcutta was supplied with pure water no more cases of cholera occurred there, although it had formerly been ravaged by the disease. The gentlemen in Calcutta had not, however, told Koch the whole truth. For it was a fact that cholera had begun to decrease in Fort William since 1863, and yet the fresh water-supply was introduced as late as March 25, 1873. Moreover, it was not true that the only improvement then effected was a change in the water-supply, for many other changes were carried out, the fortress being made a model of cleanliness. Alterations in the drainage of the soil were effected in and around the foundations of the building, which before this was nothing more than a morass during the rainy season; so that, inasmuch as the nature of the soil, as well as the drinking-water, was changed, the case of Fort William affords an argument as much in favor of the localists as it does for the contagionists. I may here call to mind an episode which was much commented on at the time, and which is perhaps of the nature of an experiment. Macnamara writes, in his work on cholera: "In connection with this position I may narrate a case which happened in another part of the country, but for which the facts can be vouched. Some dejecta from a case of

cholera found their way into a jug of drinking-water, and the mixture was exposed to the heat of the sun for the day. Early the next morning a small quantity of this water was drunk by nineteen individuals. Nothing was noticed, either in the appearance or taste of the water, by those who had partaken of it. All remained well during the first day. On the following morning one man was seized with cholera as he awoke; the others remained well till the second day had passed, when two more cases of cholera occurred, and the day after that two other cases were observed. The rest of the party remained well till sunset of the third day, when again two were seized with illness. These were the last cases, and the other fourteen persons continued to enjoy immunity from diarrhœa, cholera, or any disturbance of health." This case is, etiologically, not worth much. Where was the original case from which the infection was supposed to have come? Was it not possible for the nineteen persons to be brought under the same circumstances as those under which the original case had become affected? Were the nineteen in a place which was as a rule free from cholera, and could they only be affected through the drinking-water? Several cases in India are known to me where guests at a banquet having drunk no water were yet the victims of cholera. For instance, at a baptismal feast which a sergeant gave, a gallon and a half (six litres and three quarters) of rum was supplied. Twelve persons, including the man and his wife, sat down to the banquet, and on the following evening the whole of the group, except the baby which still lives in Calcutta, were in their graves. At this feast there was no question of a mixture of anything with the stools of cholera.

When I ask myself how it is that men usually astute can place such implicit reliance on the drinking-water theory, which entails such ambiguity and contradiction, I can only think of two reasons. Partly, no doubt, there exists the belief that on general hygienic grounds no stone should be left unturned in order to procure a good supply of water where it had previously been bad, and thus the fear of death and the devil proves stronger than the love of truth and God. Again, the drinking-water doctrine appears to many to be the lesser evil as compared with the threatening local and periodical predisposition, which implies a more mysterious and less definable conception. They imagine that the (to them) uncomfortable facts of time and place may be explained on the drinking-water doctrine. The places where the cholera excreta can contaminate the drinking-water have a local disposition, and the times at which even cholera prevails, and excreta may contaminate springs and water-courses, have to do with periodical dispositions, and thus they escape from explaining the subtile influences of soil and ground-water. But any one who thoroughly investigates the local and periodical factors in epidemics of cholera must reject such an explanation. A study of the tables previously given from Brauser places great obstacles in the way of accepting these doctrines.

The constant periodicity of cholera in Calcutta or Madras can not thus be cleared up. In the same way it is impossible to understand on this doctrine how it is that the hot, dry season, which must be destructive to the bacilli, is the period during which cholera is most prevalent, and how it is that in the hot and wet season, which is favorable to the growth of bacilli, cholera is at its lowest ebb. That cholera and typhoid fever are more flourishing when the ground-water is sinking than when it is rising has been explained by the drinking-water theorists on the view that when the ground-water is falling it becomes more concentrated, thicker, and therefore more dangerous. Now, the prolonged researches of Wagner, Aubry, and Port have proved the direct opposite. When the ground-water is low it is always purer than when high. Dr. Port has studied for a number of years the state of the water in the garrisons of Munich, with a view of watching its relations with the movement of typhoid fever, and he has found that when the water began to be impure then a falling off in the disease might be predicted. Why this should be so has received an experimental explanation from Dr. Franz Hoffmann. Great and numerous are the objections to the explanation of the local disposition to cholera by means of the drinking-water doctrine. Lyons was until the year 1858 supplied with water from superficial wells. The analyses of the waters from a number of the wells prior to the introduction of a better supply would astonish any one. The contagionists get out of their difficulties by merely asserting that though it is always the water which transmits cholera, yet there are a thousand ways in which this may be accomplished. But we have already shown that severe epidemics may occur without drinking-water being implicated, and consequently it is questionable whether, in those epidemics where the water may have been a factor, other causes did not play a more important part in the development of the malady. It is for the contagionists to prove why the infection by drinking-water can only be verified in certain cases. The most popular argument of the contagionists is the proposition that cholera spreads by human intercourse, a fact which I unhesitatingly accept. But the interpretation which the contagionists put upon the fact is nullified by the fact itself, as is shown by a closer study of all the influences of intercommunication, whether by land or sea.

In many regions there are main streets running in watered valleys in the direction of the stream, and yet other principal streets having a direction at right angles to that of the stream. In these streets, as is well known, at short intervals there exist sites which may be dotted on a special map where the frequency of cholera may be investigated, just as I had done for the epidemic of 1854 in Bavaria. It transpired that the sites of the epidemic preferred to spread in the length of those streets in the valleys which followed the course of the stream. When, however, one investigated the epidemic spots in streets which cross valleys between which hills or table-lands lie, it was found that

the cholera attacks those sites which lie in a valley which crosses the streets, and the places which are situate on the heights between two valleys are spared. In the valleys, however, which are only crossed by one principal road, the epidemic spreads itself in places which lie in the valley upward and downward in the direction of the river, although the intercommunication may be very slight and the river not navigable. In Central India for a long time the great rivers were the principal means of communication, and the cholera spread by preference along these routes. When in recent times the Indian railways were started, it was thought that cholera would forsake the old routes and travel along the railway. But such was found by Cornish not to be the case. Of course, the same statement holds good in Europe. Saxony is perhaps as thickly peopled and as much overrun with railways as any state in Germany. Since 1836 cholera prevailed in Saxony on no less than eleven different years; but, as Reinhard and Günther have proved, its propagation was not in any way directed by the developing net-work of railways. Certain places in Saxony always were the centers for cholera, and so remained despite the railways. Freiberg, in Saxony, was never visited by cholera either before or after the railway was completed, while certain parts of the Mulde and Pleisse Thal were regularly visited. As often as an epidemic of cholera broke out in North or South Germany, cases were observed in Saxony; but for an epidemic to develop in Saxony always required time. Every year in Saxony which was marked by a heavy death-rate from cholera was preceded by a year during which the mortality was comparatively slight. Thus, in 1849 there were 488 deaths; in 1850, 1,551; in 1865, 358; and in 1866, as many as 6,731; again, only four cases in 1872, but 365 in 1873.

If the cholera can be brought by sufferers direct from India to Toulon, where the sea-passage lasts only three weeks, then if the disease prevail in North Germany it must always spread to South and West Germany, and inversely, since we have nothing but cholera on the one hand and healthy people on the other. But whoever studies the history of cholera will find nothing but contradictions of this postulate of the contagionists. In 1854 Berlin took no cholera from Munich, and in 1866 Munich received no cholera from Berlin, notwithstanding extensive intercommunication during the Industrial Exhibition and despite the war.

A PROJECT IN INDUSTRIAL EDUCATION.

By FRANKLIN HAVEN NORTH.

THE "children of the public," as the street Arabs are called by that agreeable writer, Edward Everett Hale, are known for their acuteness rather than for their docility. The *mots* of the Paris *gamin* give to the French *feuilleton* not a little of its spice, and his Anglo-Saxon pro-

totype, though more subdued, is no less ready at repartee. Each gives evidence of an acute mind and a keen perception. But playing in the street, vending the public prints, running of errands, and like employments, do little to instruct or elevate, and, though by no means barring the door to more praiseworthy and remunerative vocations, are so beset with allurements as to dissuade the average youngster from entering. Reared in the street, he is accustomed to excitement, and, as he grows up, discovers neither aptitude for trade nor inclination for any other occupation. In the city of New York are thousands of these street-urchins: some live in the street from choice, while others are driven thither; some go to the public schools, some to the reformatories in lieu; while others, again, add variety to their existence by devoting a part of the year to the one and a part to the other. But public schools, excellent as they are in New York, could scarcely be expected to succeed in teaching those not inclined to learn; and there are those who assert that reformatories do not reform, and hence it is that the lad who has spent the allotted time in the process of being schooled and reformed, often starts active life too young for manual labor, and too ignorant and unskilled for the work of the artisan. As a result, those are led into a career of crime or indolence whose instincts, under more favorable conditions, would have inclined them in the contrary direction, and whose latent abilities gave more than ordinary promise. Having once tasted the pleasures of untrammeled existence, they evince impatience under restraint and cold indifference to persuasion, and have, therefore, come to be looked upon as incorrigibles, and beyond the reach of charitable effort.

Dissenting from the prevailing opinion as to these lads, a number of New York business-men, having succeeded in other fields scarcely more promising, determined to see for themselves if kindly treatment and careful instruction would not serve to wean them, or some of them, from the street, and encourage them to employ their energies to better purpose. Led by Felix Adler, whose theories on this subject they had come to adopt, they established, some seven years ago, what is called the Workingman's School.

They sought to base their system upon common-sense principles, in which the manual labor of the artisan and the mental work of the scholar should go hand in hand, and both be rendered attractive. It was, too, a theory with these men, that the children of the poorest, even those of the professional mendicant, could be made, with intelligent treatment and instruction, the equals of their fellows reared amid more fortunate surroundings; and from the inception of the enterprise down to the present time they have eagerly sought out those children who, from appearance and situation, might not unreasonably be looked upon as the least promising subjects for instruction. How well they have succeeded it is not the purpose of this paper to decide. It will be sought simply to lay before the reader a general synopsis of

the plan of the school and of its practical working; and, as the system has been in operation nearly eight years with the most gratifying results, it may not, perhaps, be found a difficult task to estimate what effect, if any, such teachings, if generally introduced, are likely to produce in the condition of outcast children.

The system may be said to be original, since it is not founded upon any other known to exist. It is best adapted to a country where republican ideas prevail, and where, as in the United States, the political equality of the whole people is the fundamental principle of government. The underlying principle of the system, and one which it is sought to impress upon the minds of the little workingmen is, that all labor is honorable, and that greater dignity should attach to hand-labor. The managers maintain, and few will be found to dissent from the opinion, that the most effective means of raising the dignity of hand-labor is by improving the condition of the workman; educating him in his calling, making him self-reliant, original, progressive; and to this end they bend all their energies.

It may not at once appear how hand-labor is dignified by making expert artisans of children plucked from the streets. But it should be remembered that in this country there is no class distinction: men may rise as far as their abilities will take them; the lowest in origin may aspire to the loftiest position, with none to ask them whence they came.

Unlike the industrial school, no age is fixed upon for entrance into the Workingman's School. That period of a child's life at which it breaks things in order to see what makes them go has been selected as the best time to begin to instruct its mind and direct its hands. In the industrial school certain trades are taught; youth is forced to look upon the stern realities of life, the coming struggle for bread, and to fix upon particular vocations ere yet the natural preferences are sufficiently developed to enable it to do so. When the course is completed, there is no time to change; the daily bread must be won, and thus it not unfrequently happens that he who would, perhaps, have been successful as a decorator, proves but an indifferent carpenter; and one who could easily have earned a competence as a mason is forced to eke out a scanty livelihood as a molder, a locksmith, or perhaps a brass-finisher. In the Workingman's School, though all the principal trades are represented, no effort is made to incline the little workingmen to the one or to the other.

Again, in the public school from which many of these little fellows are deserters, no allowance is made for the grades of intellect or rather for the various conditions of intellectual development. It is a ponderous educational machine, in which a certain amount of raw material being put in at one end will, in a given time, be passed out at the other in a more or less finished condition. The bright subjects, always in the minority, are, no doubt, much benefited; the others, upon

leaving, can have scarcely more than a confused idea of what they are supposed to be proficient in. At given times they have been served with a given quantity of mental nourishment, but, as those seated at table are not always able to partake of the same food in the same quantities at stated periods, so pupils, however endowed by nature, can not always digest new ideas nor investigate new subjects with equal readiness.

The theory of instruction is based upon natural inclination. A child visiting the circus, menagerie, museum, or theatre, is all eyes, all ears. Question it upon its return home, and you will, doubtless, be surprised at the amount and variety of its information. It has seen and heard that which you have failed to see and hear.

It is this faculty of the child of absorbing itself in what pleases or interests it that has been seized upon by the managers. In the public school, the young, restless with the impatience of childhood, are forced to remain quiet while attempts are made to describe to them a something which they have never seen, and, not being based upon anything in which their interests have previously been excited, leaves, at best, but little impression on their minds. When it has begun to dawn upon them that Columbus was a man and not a fish, and that he came hither in a sailing-vessel and not in a steamship; when they are a-hunger and a-thirst for information as to his reasons for believing there was a New World in the West, the bell rings and they are ushered into the awful presence of an arithmetician, who knows all about the denomination of numbers, circulating decimals, and the like, and who, having memorized all the rules, thinks everybody else should be compelled to do the same. This system of opposing the natural inclinations of the young is, perhaps, best expressed in the retort of the lad to his mother when she told him to go to bed early in the evening: "You make me go to bed when I'm not sleepy, and get up when I am!"

An inclination of the visitor to the Workingman's School, as he looks over the heads of the children at work, is to compare their lot to his own when a boy. Unless he was unusually gifted, he will recall the tedious hours he spent while trying to memorize the rules in his grammar—rules which he didn't always understand—the struggle with the coefficients of the *n*th power of binominals, and so on. He will remember with what reluctance he sometimes entered the school-gates and with what satisfaction he often closed them behind him. Holidays were marked with a red letter in his diary, and vacations not infrequently looked upon as the condemned are wont to look upon temporary respites. But now, as he looks about him, he sees children absolutely interested in their studies and their work. And such work! —molding with moist clay, cutting, sawing, and planing with real tools, fashioning artistic designs, and so on.

The youngsters of his day often absented themselves from school, and stolidly took the punishment which such dereliction entailed, in

order to witness work of this nature at a neighboring manufactory or workshop. Now, he beholds a school which is a workshop in itself; where the boys, instead of having to content themselves with looking on, are permitted to take an active part. He sees whole classes of children interested in arithmetic, algebra, and geometry, and listening to talks upon geographical and historical subjects with evident relish. In his day the allurements of geography were by no means so strong as those of foot-ball; and he never could get himself to look upon mathematics with that ardor of affection which he was wont to bestow on mumble-the-peg.

By what arts, it may be asked, do the teachers at this particular school succeed in suddenly awakening the interest of children in subjects which heretofore have not particularly attracted them? By making them interesting instead of tiresome. How many children will be attracted by the statement that Africa is the division of the world which is the most interesting, and about which the least is known; or that Afrigah, from which its name is supposed to be derived, is said to mean "colony" in the ancient Phœnician, and, having been given by the founders of Carthage to their territory, is supposed to have spread to the whole continent?

But children are ever ready for stories and the relation of exciting adventures, and through this faculty, it has been found, they may be led on from one event to another of African history, from one point to another of African topography, till, finally, what heretofore they may be said to have regarded as an unpalatable dose, is successfully administered in the form of a sugar-coated pill.

Instead of beginning at the commencement of African history, at least at the point where our knowledge begins, and gradually working forward through all the dry details, the contrary course would be pursued at the Workingman's School. The children would be told about Stanley and how he found Livingstone. This would naturally lead to Livingstone, and to why Stanley went in search of him. Then would follow the mission that brought Livingstone to Africa; the Nile, and the various conjectures regarding its source, and the reason of the world's impatience to know it; the Niger, and the interesting story of the finding of its course by Richard Lander, after his master had failed in a similar attempt. Egypt and the Suez Canal would be gradually worked in, as well as the history of the Continent of Africa and its relative position on the earth's surface.

By such a course, it has been found, connected ideas are given of geographical points and historical incidents and eras. The mention of ancient Greece to one so instructed would mean something more than a portion of land included in the most easterly of the three peninsulas in the south of Europe, and which, beginning at latitude 40° north, is bounded by a chain of mountains extending from the Thermaic Gulf on the east, and terminating with the Acroceraunian promontory on

the Adriatic in the west. It would bring to his mind a connected chain of events.

In teaching algebra, geometry, and trigonometry, objects are used as much as possible. Thus, in the latter, the reason why the angles are not employed as in geometry, but in their stead certain of their functions are used, is practically demonstrated. Then a system of triangulation might be begun by the scholars, in which a base is measured from a single known point, the latitude and longitude of which are computed, and the azimuth-compass brought into play to find the true direction of the line. From this base, other triangles and finally quadrilaterals might be laid off and computed as well as the curvature of the earth, which is traversed and comprehended by the scheme of triangulation. The amount and variety of the information which the young are capable of receiving when their interests are excited would surprise those who, perhaps, have had neither the time nor the inclination to observe them.

The little workingmen are instructed in decorating, molding, turning, the work of the forge, carpentry, and are made to take an active part in experiments in mechanics, hydrostatics, hydraulics, sound, heat, light, electricity, and magnetism. They are retained in the school until they thoroughly comprehend their work and studies.

The children who fill this great building from top to bottom look to be those of well-to-do people, for their clothing is tidy, their faces clean, and their eyes bright. Such, however, is not the case. The school-workshop is recruited from districts the most squalid, from abodes the most humble. No origin is so low, no intellect so dull, that it may not demand and receive admittance within these hospitable, catholic walls.

In the eyes of many this will, perhaps, be looked upon as the most commendable feature of the institution.

Those whom curiosity or other motive has led into the by-ways and the somber courts that mark the abiding-places of the very poor laboring-man have often recorded their conviction that here is the best, though perhaps the most difficult, field for philanthropic work.

The difficulties that stand in the way of such an enterprise as the Workingman's School are sufficient to dissuade the ordinary enthusiast in such projects. They can best be understood by those who are sufficiently interested to inquire into the whole scope of the undertaking. Children, especially those of the poor, are often very hungry early in the day, and to attempt to instruct or even amuse them under such circumstances is alike idle and illogical. Again, poor children frequently lack proper clothing to protect them from inclement weather. All this has been foreseen by the managers. A midday meal is provided for the children, and clothing when required is distributed with no niggard hand.

As might be expected, children are continually being received into the school who are unclean and accustomed to uncleanly habits. These are washed and taught to keep themselves clean. Those come, too, into whose young lives no spark of happiness has ever entered, who are sad and do not smile, and it requires no little skill to induce them to forget their childish woes, and take part in the games and occupations of their comrades.

But it is in dealing with character in its various phases that the managers would seem to have scored the most marked success.

There are those who, like Henry George, believe that humanity is much the same; that a cruel instinct may be traced to a childhood which no spark of kindly solicitude ever served to brighten, and sullenness and obstinacy to a novitiate of injustice and ill-treatment. Others there are who insist that, as the father, so is the child, and these may be set down as agreeing with Hesiod, who distributed mankind into three orders: The first, he says, belongs to him who can by his own powers discern what is right and fit, and penetrate to the remoter motives of action; the second belongs to him that is willing to hear instruction and can perceive right and wrong when they are shown him by another; but he who has neither acuteness nor docility, who can neither find the way by himself, nor will be led by others, is a wretch without use or value.

"If any one denies," says Herbert Spencer, "that children bear likenesses to their progenitors in character and capacity, if he holds that those whose parents and grandparents were habitual criminals, have tendencies as good as those whose parents and grandparents were industrious and upright, he may consistently hold that it matters not from what families in a society the successive generations descend. He may think it just as well if the most active, and capable, and prudent, and conscientious people die without issue, while many children are left by the reckless and dishonest. But whoever does not espouse so insane a proposition must admit that social arrangements which retard the multiplication of the mentally-best and facilitate the multiplication of the mentally-worst must be extremely injurious."

Now, with no desire to affirm the proposition of the one, nor to point out the fallacy of the other, let us see what has been the experience of the managers of the Workingman's School in this regard; let us see how much heredity of temperament and inclination has there been exhibited by juvenile humanity while under treatment.

As may readily be seen, if only the promising children could be permitted to enjoy the benefits of the school, and the vicious and stupid children were excluded, the work of the projectors, if it did not fail utterly, would, at least, be greatly restricted in its scope, and wanting in that particular attribute whence the most important results were looked for.

It is, perhaps, not immediately obvious how it can affect a scheme

by which it is sought to train a certain number of poor children, if the vicious be excluded. But the theory of the founders of the institution is that children are not naturally vicious, but are rendered so by surroundings or influence; and hence, if they failed in successfully dealing with them, they would be compelled to fall back upon the assertion that bright and well-behaved children may be made into expert artisans —a proposition which no one has ever denied.

Fortunately for them and fortunately for those whom they especially set out to aid, not one child out of that multitude which has applied for admission has been found to be beyond the reach of intelligent treatment; not one has been found where evil propensities were more than skin-deep.

Strange to say, the lad who upon entry proved the most stupid, most stubborn, and ill-mannered, rose by rapid stages until, finally, he reached the head of his class! This lad, upon his first appearance, was found to be not only dirty and ragged, but so obstinate that he would only answer questions when it pleased him to do so. His eyes were half closed, he rarely looked up, and altogether he seemed, if the description of those who saw him may be relied upon, more fitted for the career of a cow-boy or that of a bandit than for such peaceful occupations as those of the mechanic and decorator. The manager of the school called up the official physician and asked him what ailed the lad. The physician made a careful examination, and then reported that, besides being naturally vicious, the lad was weak-minded. But this was by no means satisfactory to the manager. He examined the lad himself, and made an altogether different diagnosis of the case. In his opinion the lad's behavior and appearance were due to a long course of ill-treatment and neglect. He had him thoroughly washed, fed, and clothed, and prescribed good treatment.

At first he was dull, very dull; his mind seemed never to have been called into action, but little by little he began to wake up; day by day his eyes opened wider and wider; the cloud that seemed to have settled over his face was gradually dispelled; and finally one day, when something more interesting than usual was afoot, he so far forgot himself as to smile. Henceforward he gave no further trouble. His teachers say he made rapid progress, and they finally discovered that, instead of being mentally weak, as the physician had said, he possessed a mind unusually acute.

Many of the children when first entered exhibit that viciousness which, it is alleged, is inherent in those whose parents are of a class essentially vicious. These children, or many of them, may be said to have been reared in the gutters, and they found even the gutters more agreeable than the darkened, squalid chambers provided for them in the adjoining tenement-house, and willingly risked the dangers of the crowded street without rather than endure the ill-treatment to be had within. At first they show a disposition to repel the advances of

those who would do them a service, as if, unaccustomed to kindly treatment, they felt these advances only concealed new projects for their discomfiture. A supply of new clothes and a few comfortable and palatable meals do much, it has been found, to dispel this feeling, and the round of interesting tasks set before them, in which the hands as well as the mind are called into action, has a still more powerful effect in awakening the better instincts of childhood.

The experience of the Workingman's School tends to verify the conclusion of an eminent writer, that the theorem relative to the moral and intellectual debasement of societies would, when pushed too far, have consequences even more inadmissible than that relative to their physical debasement, and that the principle of mental and moral debasement is by no means so much to be relied upon as the law of physical heredity.

This conclusion has not been reached by a course of reasoning but by actual observation, and though, of course, it does not go far enough to be conclusive, furnishes, nevertheless, valuable data; data which may yet do much toward refuting, at least in part, the arguments which have from time to time been put forward by learned reasoners.

The children of what might be called professional mendicants have shown, when their intellects were polished up and dusted off, as we might say, not a whit less intelligence nor more uncanny characteristics than their fellows; the children of intelligent workingmen; and he would be a bold man who, after observing the present condition of these children, should predict that, when cast loose with an artisan's education, both practical and theoretical, they will fall back upon the charitable institutions instead of earning their own bread and butter; and he would be no less bold who should prophesy an ultimate career of crime for those children who were gathered, while very young, from the haunts of the criminal and the outcast.

This is no scheme of indiscriminate charity in which those who are the most importunate get the most relief, nor is it an institution where the children of the well-to-do may get an artisan's education gratis. There always has been plenty of encouragement for the workers in the great human hive, but here is a project to stimulate those who might not unreasonably be expected, on account of their surroundings, to be the drones and the criminals of the future, into honest activity, and enable them to obtain by their own industry more wealth or comfort than could be hoped for in a career of crime or indolence.

THE PAINLESS EXTINCTION OF LIFE.*

By BENJAMIN WARD RICHARDSON, M. D., F. R. S.

DURING the latter part of 1883 and the early part of 1884, I constructed at the Dogs' Home, Battersea, at the request of the committee of that institution, a lethal chamber for the painless extinction of the life of the animals which have, of necessity, to be destroyed there. I put the process first into operation on Monday, May 15th, by subjecting thirty-eight dogs to the fatal narcotic vapor. They all passed quickly into sleep, and from sleep into death. Since that time, for a period of seven months, the lethal chamber has been regularly in use. From two hundred to two hundred and fifty dogs per week have been painlessly killed in it, or a total of nearly seven thousand.

The thought of applying the anæsthetic method to the painless destruction of the lives of the lower animals, and the first accomplishment of it, came from myself, and dates back as far as the year 1850. In that year, I constructed at Mortlake, where I was then starting in practice, a small lethal chamber, to which my neighbors would frequently bring animals which they wished to have killed. In 1854 I began to illustrate this mode of painless death, and from that time up to 1871 I never allowed the subject to rest. In 1871 I brought it formally before the Medical Society of London. About this same time I made a communication to the Royal Society for the Prevention of Cruelty to Animals, and suggested a mode for killing painlessly dogs and cats that were wounded in the streets. From that time I have continued the inquiry, making use of all the known anæsthetic substances, in order to ascertain which was cheapest, most adaptable, most certain in action. The information thus obtained proved very useful when the time came for utilizing it.

In undertaking the practical act of carrying out lethal death on the large scale required at the Home, I had to determine, in the first place, on the anæsthetic or anæsthetics to be used; and, in the second place, to construct the room or chamber in which the animals should be confined while exposed to the lethal gas or vapor. I have placed on the wall a table of anæsthetics, including most that have up to this time been discovered, with a general outline of their respective properties and values. There is, you see, a goodly list, twenty-two in all. Out of these I selected, as shown by experiment to be the best, four: Carbonic oxide, chloroform, carbon bisulphide, coal-gas.

Carbonic Oxide.—I was led to carbonic oxide, not only by reading of it, and by witnessing the effects of it as a poison when it has been breathed from coke-fumes, but specially from studying its action when

* Abstract from "Journal of the Society of Arts."

TABLE OF ANÆSTHETIC GASES AND VAPORS.

NAME OF SUBSTANCE.	Elementary composition.	Material condition.	Gas or vapor density H=1.	Fluid density, water = 1.	Boiling-point.		PHYSICAL QUALITIES.
					Cent.	Fahr.	
					Deg.	Deg.	
Nitrous oxide	NO	Gas	22	....	..	..	Supports common combustion; sweet, and not irritating to breathe.
Carbonic oxide	CO	Gas	14	....	..	..	Burns in oxygen; not irritating to breathe.
Carbonic acid	CO_2	Gas	22	....	..	..	Extinguishes flame; irritating to breathe.
Bisulphide of carbon	CS_2	Fluid	38	1·270	48	107	Vapor burns; odor disagreeable unless well purified.
Hydride of methyl (marsh gas)	CH^3H	Gas	8	....	..	..	Burns in air; inodorous, not irritating.
Methylic ether	C^2H^6O	Gas	23	....	..	..	Burns in air; almost inodorous when pure.
Methylic ethyl ether	C^3H^8O	Fluid	30	....	11	52	Burns in air; ethereal odor; rather pungent.
Chloride of methyl	CH^3Cl	Gas	25·25	....	..	..	Burns in air; rather pungent.
Bichloride of methylene	CH^2Cl^2	Fluid	42·5	1·320	40	104	Vapor burns; pungent odor.
Chloroform	$CHCl^3$	Fluid	59·75	1·480	61	142	Vapor extinguishes flame; pungent odor.
Tetrachloride of carbon	CCl^4	Fluid	77	1·560	78	172	Vapor extinguishes flame; odor fragrant, not pungent.
Hydride of ethyl	C^2H^5H	Gas	15	....	..	..	Burns in air; inodorous.
Ethylic ether (absolute ether)	$C^4H^{10}O$	Fluid	37	·720	34	93	Burns in air; pungent to breathe.
Chloride of ethyl	C^2H^5Cl	Fluid	32·25	·921	11	52	Burns in air; ethereal odor; rather pungent.
Ethylene (olefiant gas)	C^2H^4	Gas	14	....	..	..	Burns in air; pleasant to breathe.
Bichloride of ethylene (Dutch liquid)	$C^2H^4Cl^2$	Fluid	49·5	1·247	80	176	Vapor burns; ethereal odor; rather pungent; smoky.
Chlor-ethylidene	$C^2H^4Cl^2$	Fluid	49·5	1·174	64	147	Vapor burns; ethereal sweet odor; pungent.
Bromide of ethyl (hydrobromic ether)	$C^2H^5B^2$	Fluid	54	1·400	40	104	Vapor rather pungent, but pleasant.
Hydride of amyl	$C^5H^{11}H$	Fluid	36	·625	30	86	Vapor burns in air; inodorous when pure.
Amylene	C^2H^{10}	Fluid	35	....	39	102	Vapor burns in air; pungent; smoky.
Hydrocyanic acid	HCN	Fluid	..	·705	26	70	Vapor painful to breathe; special; suffocating odor.
Coal-gas	....	....	..	....	..	..	Gas at first slightly irritating, but quickly narcotic.

evolved from the fumes of the *Lycoperdon giganteum*, or common puff-ball. The fumes as thus evolved have been employed for centuries past by the common people for narcotizing bees before taking the honey from the hive. A portion of the substance being burned under the hive, the bees, inhaling the fumes, fall into a deep sleep, during which time they are unconsciously deprived of their industrious earnings. I was so struck with the perfect action of these fumes after being shown one of these experiments, that, in 1854, I introduced the fumes for anæsthetic purposes. Purified by being passed through water, they produced the most rapid narcotism, under which many operations were performed painlessly on the inferior animals. The question was the character and chemical nature of the agent in the fumes which produced the anæsthesia. The late Dr. John Snow, so well known for his immense labors on anæsthetics, and the late Mr. Thornton Herepath, one of our most promising chemists, were each separately engaged in discovering the concealed gas or vapor. Snow and Herepath simultaneously, but by quite different methods of research, arrived at the fact that the narcotic present was carbonic oxide,

or the same gas as is produced during the combustion of carbon or coke in a limited supply of oxygen.

These researches led me to study the action of this gas in its pure form, and to the discovery of many curious facts relating to it. Among other things, I noticed that, like oxygen, it made the venous blood of a bright-red color, and that warm-blooded animals exposed to it for a long period of narcotion are rendered temporarily diabetic.

I did not, on the whole, think it commendably safe as an anæsthetic for man, but I fixed upon it at once as one of the best and cheapest of lethal agents for the painless destruction of life in the lower creation. It is the principal agent for this purpose which I have used since the date named above, 1854.

Carbonic oxide is a gas, and, if quite pure, is so odorless and produces so little irritation that, when present in the air, it is apt to be breathed unconsciously until the effects of it are felt. Those who by accident have been narcotized by it, and have recovered from the effects, have expressed that they had no recollection of anything whatever, that they passed into sleep in the ordinary way of sleeping, and knew no more.

Chloroform.—I was naturally led to chloroform, by reason of its common use as an anæsthetic. There is no anæsthetic more certain in its action, and none more certain to kill if it be administered in a determinate manner. Administered even with skill, so as not to kill, it proves accidentally fatal about once in twenty-five hundred times, and, so soon as air is charged with over five per cent of its vapor, it is not breathed without danger. Death from it is very determinate when it occurs, and seems to be entirely painless. The vapor of chloroform does not burn; on the contrary, it extinguishes flame. If we plunge a lighted taper into a jar through which the vapor of chloroform has been diffused, the light is at once extinguished. When we use it for narcotism, we merely diffuse the fluid into the state of vapor, and make provision for the vapor to be absorbed by the lungs of those subjected to it. It produces little irritation when breathed.

Bisulphide of Carbon.—The bisulphide of carbon is a very rapidly-acting anæsthetic. It produces narcotism, in fact, almost as quickly as carbonic oxide, and with less muscular commotion. The vapor of it burns in air if a light be brought near to it; but, when its vapor is mixed with that of chloroform, this danger is avoided. It is bought as chloroform is, in the fluid state, and can be obtained, therefore, from the chemist directly, ready for use, by diffusion of its vapor. It has one immense advantage, that of being excessively cheap; and it has one great disadvantage, that of being excessively unpleasant in regard to its odor, unless it be most carefully purified by repeated distillations. Combined with chloroform, with which it mixes freely, the peculiar odor is largely reduced, and, by pouring the mixture over chloride of lime, is almost entirely removed. For this reason, together

with that relating to the difficulty of combustion of the combined vapors, I have used largely in these researches the mixture of chloroform and carbon bisulphide. The combined vapors produce also a singularly good antiseptic atmosphere.

Coal-Gas.—Common coal-gas is one of the most potent of narcotizing gases. It is a compound of four gases, three of which are excellent narcotics, and one a negative gas—forty-seven per cent of hydrogen, forty-two of marsh-gas, three of heavy hydrocarbons, and eight of carbonic oxide. All these gases are anæsthetic in their action: marsh-gas is one of the best, and carbonic oxide is one of the quickest; but they are all explosive.

For the lethal purpose, nothing could possibly surpass coal-gas. I put it freely to the test, and found it was all that we could desire. In an atmosphere containing twenty-five per cent of this gas, an animal goes to sleep in from two to three minutes, and dies asleep as easily as in any narcotic vapor or gas whatever. The gas is always at hand, and for the present purpose is the cheapest and readiest of all. Under such circumstances, it seems absurd to think of going any further for a narcotic agent. And yet it is necessary, at all events, when a large lethal chamber is wanted, on account of the danger from explosion. All things considered, I was led to conclude that carbonic oxide was the best narcotic agent to employ, combining it with chloroform or carbon bisulphide, if that should prove necessary. Deciding on this point, the next question was how to manufacture the carbonic oxide so as to bring it into practical use on the easiest as well as the largest scale.

After making some unsatisfactory experiments, I luckily recalled Mr. Clark's condensing-stove. This is a most ingenious invention. The fumes proceeding from the combustion in the furnace first ascend and then descend through two lateral columns, to escape by a tube directed over a trough or saucer. A large quantity of water-vapor is in this way condensed, and is collected at the base of the stove, together with substances derived from the combustion, which are soluble in water. Here, with a little modification, was what I wanted. To adapt the stove to my purpose, I got Mr. Clark to make a charcoal furnace over a gas-burner, so that, when the charcoal was laid in the furnace, it could be instantly set alight by merely turning on and lighting the gas, letting the flames of gas play through the charcoal. Next I got him to make a large condensing cistern beneath the stove, with an opening from it to convey the carbonic oxide by a tube into the lethal chamber, and with a tap, by which the condensed fluid could be drawn off. The arrangement answered straight away, if I may so say. The immediate combustion of the charcoal by the gas yielded very nearly the theoretical value of the product, carbonic oxide. The gas was deprived of water by the condensation; it was delivered over to the chamber with a steadiness sufficient for all practical necessities;

it was cooled without any other artificial means, so as never to raise the chamber above summer heat; it was produced cheaply; and it afforded such simple action that any workman could at once learn to use it. Another useful result springing from the employment of this stove was, that it enabled me to diffuse other narcotics into the chamber, by merely allowing the warm gas proceeding from the stove to pass over a porous surface, charged with the narcotics, on its way into the chamber.

To apply the narcotic gas or vapor, it is necessary to have a closed place in which the animals are exposed to the narcotic, and another place in which they are collected preparatory to being subjected to the narcotism. This implies what I have called the lethal chamber, and a cage. At Battersea, it was necessary to have an apparatus large enough to narcotize as many as one hundred dogs at a time. It was, therefore, essential to have a large lethal chamber, and one that was strong and effectively constructed. I noted down at the beginning the following requirements, all of which I had calculated out of a series of preliminary studies, and constructed on a small working scale.

1. The chamber, of whatever substance built, must be so constructed that its interior shall not be subject to great variations of temperature. This I knew to be very important, since, in observing the action of narcotic vapors on the human subject, I had learned that humidity and cold materially interfere with their quick action, while dryness and warmth favor such action. In a lethal receptacle, such as was being constructed, there could be no certainty whatever, unless the temperature and dryness were at all times uniform.

2. It was necessary so to construct the chamber that sufficient but not an excess of room should be allowed in it for the expansion of the gases introduced. It might seem at first sight, and before inquiry was instituted, that the more the space within the chamber was reduced the quicker would be the effect. This, however, is not practically the fact. In order to secure perfect diffusion of the narcotic atmosphere, the space to be filled with it must be about one eighth greater than is absolutely required for a cage, fully charged with the animals that have to be killed.

3. Much care is required in connecting the stove with the chamber, so as to make sure of equal diffusion of the gases or vapors through the inclosed space. Unless this equal diffusion is rendered effective, some of the animals are more exposed to the vapors than others, and the effects are irregular, which is as bad a result as could possibly be obtained.

4. It was essential to provide that a sufficient quantity of the narcotic should be introduced before and for a brief period after the introduction of the animals.

5. It was requisite to invent a plan by which the chamber could be kept completely closed until the precise moment when the animals

have to be introduced, then instantly opened for the introduction, and as instantly closed after the introduction. It was equally requisite to guard the entrance into the chamber, so that the men employed in pushing in the cage should be protected from the vapor. A method had also to be adopted by which it could be known when all the animals had ceased to breathe.

To meet the first of the above-named conditions, I constructed the lethal chamber (the outline of which is shown in Fig. 1) of well-sea-

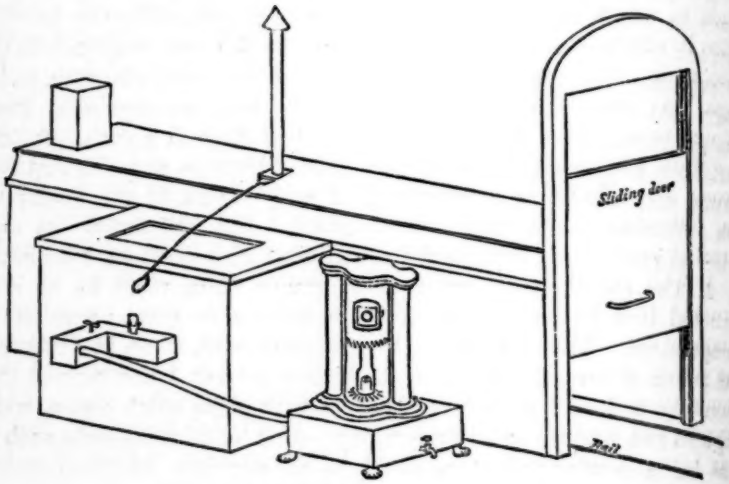


FIG. 1.—THE LETHAL CHAMBER.

soned timber, making every part of it a double wall, and filling the interspace closely with sawdust.

In order to obtain the slight excess of space which was wanted to insure diffusion, I formed on each side of the chamber an extra space, which I call a pocket. They are in the center on each side, and stand out as aisles from a central nave.

In order to secure quick and equal distribution of the vapors through the chamber from the stove, I let the gases in at first from the top, under the impression that the gases, being heavier than the atmosphere, would be made to pass with greater rapidity into all parts. Theoretically, this view is correct; but, as it became necessary to have two floors or tiers to the cage, I was obliged, in the end, to let in the gas half-way down the sides of the chamber. By using two stoves, one on each side, this method of introduction was both convenient and effective. To remove the common air, an opening, with a shaft of ten feet, was made in the roof. The shaft has a bore of three inches, and has a cap at the top, in order to prevent down-currents of air. At the foot of the shaft is a damper, which can be opened and closed at pleasure.

To meet the fourth necessity, a plentiful supply of the narcotizing vapor, two stoves have been connected with the chamber, each capable of burning two pounds of charcoal per hour, and giving up the products of the combustion into the chamber.

To make the narcotic effect still more certain, and to keep the chamber at all times lethal, I made an extra provision. At the two points where the tubes from the stoves enter the chamber, I have interposed two strong boxes made of elm, and covered with thin lead. These boxes, which are eighteen inches long and four inches broad, are filled loosely with the porous burned loam known as Verity's patent gas-fuel, an excellent substance for filling a grate where coal-gas is burned instead of fuel. This substance is so porous, it takes up narcotic fluids most readily, holds them in its pores, and gives them up in volumes of vapors when warm gas is passed over it. Into the boxes closed in with this fuel there is a funnel, opening at the top, for supplying the fluid, which can be shut with a stopper; and at the end of the box, standing out at a right angle from it, is a continuous section, in which there is a large tap, for regulating the currents of gas from the stove.

When the stoves are in action, the tap is turned on, and the gases from the stove pass through the boxes over the patent fuel into the chamber. Nothing more is done until just before the time when the animals in the cage are to be introduced. Then ten fluid ounces of an anæsthetic mixture, consisting of equal parts of methylated chloroform and carbon bisulphide, are poured upon the fuel through the openings in the top of the little boxes, the openings being immediately closed. After the animals are in the chamber, ten ounces more of the same mixture are added, and if, after three or four minutes, any of the narcotized animals are still breathing, ten or twenty fluid ounces more are poured in.

In pushing the charged cage into the chamber, there is naturally a very great displacement of gas or vapor within. It was necessary to provide an exit which would save strain on the walls of the chamber, and would let out a little gas without letting in common air. I met the problem by the plan shown in Fig. 2, which exhibits the chamber in section. Two feet from the far end of the chamber there is suspended from the top a light hanging screen, which reaches within four inches of the floor. Behind this screen, and in the roof of the chamber, is a shaft, with a valve opening upward. As the cage is pushed in, this screen is raised from the bottom, and the air, rushing out at the lower part, ascends behind, and escapes by the valve. The screen is so balanced that, when sufficient air has been extruded, its lower end reaches the back or lower end-wall of the chamber. It thus acts as a regulating valve, and, when the pressure is off, it returns to its level, letting any gas at the rear of it return toward the cage.

To enable the operators to introduce the cage quickly, and at the

same time to protect them from the action of the vapors, the following plan, also indicated in the section diagram, is adopted. The door or entrance into the lethal chamber is a slide like the sash of a window. It is placed between two strong uprights, and is balanced by a weight and pulley in each, so that it can be opened and closed with the greatest rapidity. Behind this sliding door there is placed what I call the

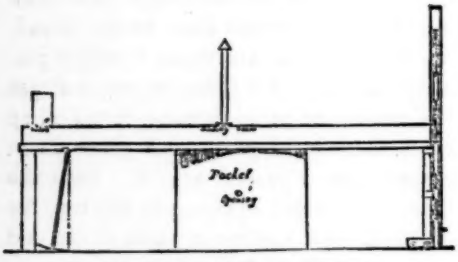


FIG. 2.—REDUCED SECTION OF FIG. 1.

FIG. 3.

shield or block; a framework of wood with four large metal valves, two opening inward, two outward. The shield is fixed on a base with four little wheels, and runs easily up or down the chamber. When the sliding door is raised, the movable valved shield is in position half a foot within the chamber, and cuts off all escape of vapor. The workmen thus have time to push the cage leisurely, after the door is raised, into the chamber, until the end of the cage touches the screen. This effected, they push the cage in a few seconds into the lethal atmosphere, the shield running before it, and then the door is slided down into its place. When all is nicely adapted, a very few seconds are required to introduce the cage and close the sliding or entrance door. When the cage is drawn out the shield is drawn out with it, by means of a cord which is attached to it, and which runs under the cage.

The last requirement which had to be met was the means of knowing when the narcotized animals had ceased to breathe. To get at this fact, the test of hearing was found to be the best. There is inserted into the chamber on one side a long stethoscope, made of bamboo; the mouth of this tube—of trumpet-shape—is in the center of the chamber, just above the cage, when that is in place. The outer part, or ear-piece, of the tube stands out four inches on the outside, and is closed when not being used, by a solid plug. On listening through this tube, the continued breathing of even a single animal can be detected, and the operators are enabled to determine if it be proper to increase the strength of the narcotic atmosphere, or to stop it.

In Fig. 4 will be seen best a description of the cage in which the animals are collected before being put into the lethal chamber. It is made of a wooden framework, with light iron side-bars. It has two sliding doors at the sides, two at one end, and one at the top. It can

be filled and emptied through these doors with great rapidity. In order to hold as many animals as possible without discomfort to them, the cage is divided into two divisions or tiers, the flooring of the upper tier being freely perforated with openings, so as to establish a com-

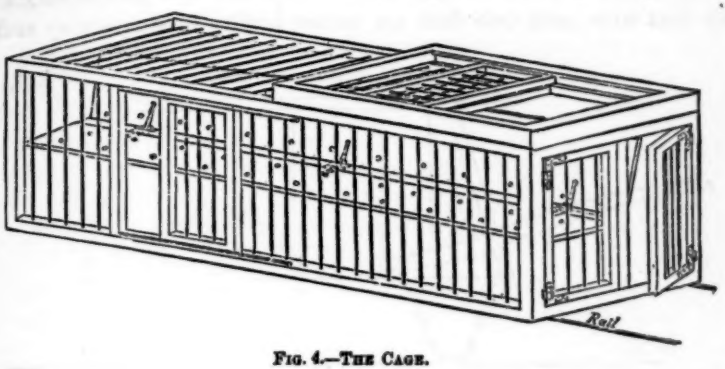


FIG. 4.—THE CAGE.

munication between the upper and lower divisions, and allow a due distribution of the gases and vapors used. The cage runs on four eight-inch wheels, which are underneath it, and ply on galvanized iron rails.

The mode of death to which the animals are subject is that by anæsthesia, not by suffocation or asphyxia. Physiologically, there is a distinctive difference between these modes of death. Death by anæsthesia is death by sleep; death by asphyxia is death by deprivation of air. Death by anæsthesia is typically represented in death by chloroform; death by asphyxia is typically represented in drowning, or in immersion in carbonic-acid gas. When properly carried out, death by anæsthesia is by far the most certain and least violent of the two processes, although both are probably painless. It is worthy of record, however, that all animals are not equally susceptible to the action of the narcotic vapors. Cats, for instance, lie asleep much longer than dogs before they cease to breathe. They fall into sleep as rapidly as dogs, but do not pass so quickly into the final sleep. There is a difference between different animals of the same kind. Some dogs die almost instantly—in fact, as they fall asleep; others fall asleep and continue to sleep for several minutes before they cease to live. In the first observations, before I had rendered the narcotic atmosphere overpoweringly active for all cases, there were a few instances, nine in the first seven hundred, in which the animals slept on from half an hour until an hour after all their comrades had died. Finding out this strange peculiarity, I increased the amount of narcotic vapor until all succumbed very nearly at the same minute, and in the last six thousand there has been no recurrence of the prolonged insensibility. The animals are now commonly all asleep in from two to three

minutes, and have ceased to exist in a further period of the same duration.

In Fig. 5 there is shown a view of the portable lethal chamber ready for use. It takes the shape of a closed truck on two wheels, and movable like a truck or barrow. It measures five feet in length, is two feet wide, and two feet six inches high. It moves very easily,

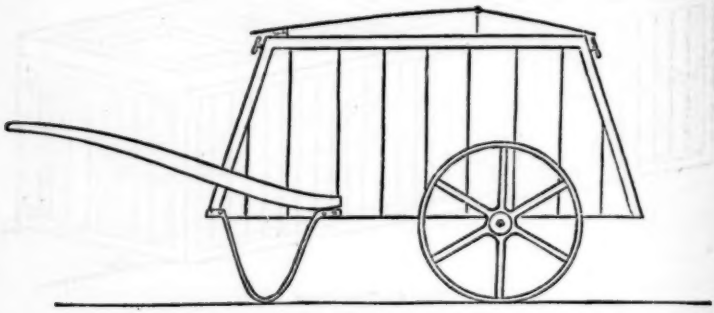


FIG. 5.—PORTABLE LETHAL CHAMBER.

and can be managed by one man. It is constructed, like the large lethal chamber, of well-seasoned wood, in double wall, with sawdust filling up the interspace. In Fig. 6 the apparatus is shown in section. There is one large chamber, having a capacity of nine cubic feet. The chamber opens at the top by a strong lid, swung from behind, which,

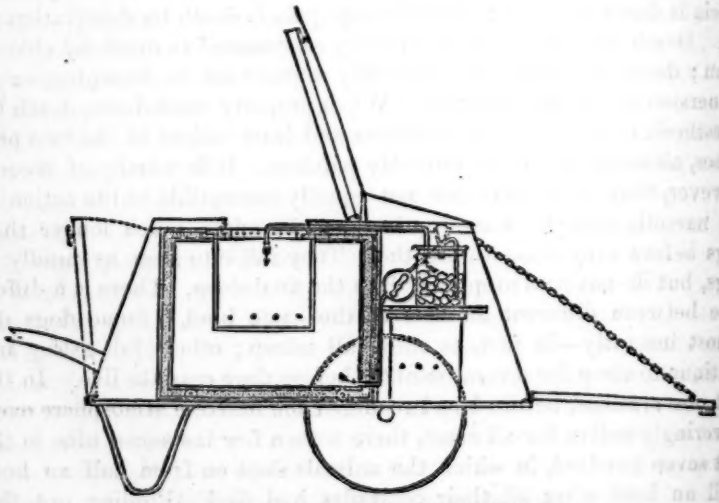


FIG. 6.—SECTION OF PORTABLE LETHAL CHAMBER.

when brought down, entirely closes it up. Under this lid there is a frame with an opening in the center, through which baskets or cages of different sizes, and containing the animal or animals, can be let

down into the larger space and held there. This larger space is the narcotizing receptacle or chamber.

At the back of the apparatus is a recess in which are placed the narcotizing fluid and the pump for forcing it into the cages containing the animals. The narcotic fluid is contained in a large, strong Wolff's bottle filled loosely with Verity's fuel. The forcing-pump is worked by a piston from the outside, and consists of a cylinder capable of containing one eighth of a cubic foot of air or gas. From the farther end of the cylinder are two tubes, one of which runs into the narcotizing chamber at the lower part, the other to the long tube in the Wolff's bottle below the surface of the narcotic fluid within the bottle. From the short or escape tube from the bottle is a continuous tube, terminating over the cage containing the animal. By an extra tap coal-gas can, if desired, be let into this chamber.

The animal to be slept into death is placed, resting on a little straw or hay, in a cage, which is then dropped into the large receptacle, the lid of which is at once closed. The handle of the piston is then moved up and down at a regular and quiet pace. As the piston is drawn out, the cylinder of the pump is filled with air from the large receptacle, and, as the piston is pushed back, it forces the air with which the cylinder has been filled through the narcotic fluid, a portion of which it raises into vapor and forces into the cage. Eight strokes of the piston charge one cubic foot of air with the narcotic vapor to saturation, and, as there are only nine cubic feet in all to charge, a couple of minutes are sufficient to charge throughout.

The animals in this apparatus pass quickly into sleep, and die not quite so quickly, but quite as painlessly, as in the larger structure.

This smaller apparatus will be so complete when it is finished that it may be wheeled from the station to a private house, if that be wanted ; or it may be used in the streets for giving painless death to wounded animals. It may also, in future, be constructed at so comparatively trifling a cost that I see no reason why every town in the country may not be in possession of one, and every small animal be spirited away in sleep. Compared with other modes of extinguishing animal life—such as hanging, drowning, poisoning by prussic acid, shooting, stunning—the lethal method stands far ahead on every ground of practical readiness, certainty, humanity.

By means of carbonic oxide, sheep can be put to sleep with the greatest rapidity before they are slaughtered. I have submitted forty sheep in this way to painless death, and found that no bad effect whatever is produced in the flesh unfitting it for food. The objection to retention of blood, so strongly felt by the Jewish people, does not obtain, the animals in the narcotic state yielding up blood just as freely as in the ordinary way, when no narcotic is used. The same process is equally applicable to swine, calves, and fowls. To oxen I do not as yet see its immediate application.

It is believed that the larger apparatus could be constructed now for from £150 to £175, and the smaller for £50.

The cost of charcoal for the stoves with the addition of anæsthetic fluid is, in the large chamber, a little over one halfpenny per animal when eighty to a hundred are killed at one time. When fewer are killed the expense is a little increased; the trouble and substance required being as little for a hundred as for a less part of that number.

FISH AND FISHING IN CHINESE WATERS.

By M. MAURICE JAMETEL.

THE Yellow Sea is distinguished above all other things by the abundance of the life it sustains, both on its surface and in its depths. Everywhere that there is enough water to carry them, in the numerous rivers and canals, and on the coast-waters of China, there are coming and going constantly boats of every shape and size, in fleets. The activity of this marine life is owing not more to the comfort with which the abundance of water-surface and the frequency of harbors allow it to be kept up than to the intense vitality and fruitfulness of the denizens of the water itself. Wherever there is a little water, organized beings increase and multiply so rapidly that the most industrious labors of the fishermen impose no check upon them, and measures to protect them would be superfluous.

Once, as I was crossing the marshes between Tientsin and Peking, I noticed here and there little ponds of water that had been left by the melting of the ice in the spring. I should have given them no attention if I had not observed some peasants wading through them, as if they took pleasure in the occupation. I asked my driver what they were doing, and he said they were catching fish. Hardly believing him, I went up to one of the ponds, and found two men engaged there, one scooping up little fish with a hand-net, and filling a basket with them, and the other catching with his hands frogs to keep company with the fishes; and this in a puddle which a European tadpole would have hardly deigned to live in.

The great abundance of ichthyic life in the Chinese waters is frequently ascribed to the high development which pisciculture has attained in the Celestial Empire. I should say, from what I have observed, that it is due to the wise pisciculture of the past, under which a reserve of aquatic life has been accumulated, so abundant that years of improvidence and waste have not been sufficient perceptibly to reduce it; for the art of pisciculture, like some other arts which once flourished in China, and are now in decay, has of late years fallen into comparative disuse.

With oysters the case is different, and the Chinese are still obliged to keep up a systematic cultivation. At Ta-kao, in Formosa, two methods of propagation are employed. The first consists in casting here and there on the mud-banks, stones, which are to be taken up again five or six months afterward, when they will be found to be covered with oysters. The other method, called by the natives bamboo-culture, is more complicated, but also more productive. In August or September the oystermen prepare a number of bamboo sticks, of about the size of a walking-cane, by pointing one end and splitting the other end to about half-way down. They wedge a flat oyster-shell into the cleft, and, bringing the splits together at the top, insert them to be held into a hole they have bored in another oyster-shell. They then plant the stakes, in close rows, where they will be covered at high-tide, so that the fry can attach themselves to them. As soon as the little oysters have formed on the sticks, the latter are transplanted to the mud-bank, whence they are pulled out, in time, covered with oysters large enough to eat. The Chinese pretend that the fry forms on the oyster-shell, and can be preserved there indefinitely. All the pains we have described are taken to promote the hatching of the eggs with which the old shells are supposed to be already covered.

The Chinese aquatic fauna is exceedingly varied, and contains representatives of nearly all the kinds that are found in the waters of Western Europe. The fishermen have given to each species a particular name, which is generally suggested by its form, or by some other distinctive characteristic. Thus, they have the war-god crab, so called because its head looks like the head of that divinity ; the little bonze crab ; and the all-sour crab, so named from its bad taste. The scientific disciples of Confucius have adopted these names in their more or less fantastic works on the natural history of the Middle Kingdom, and the painters have enriched these works with illustrations intended to facilitate the understanding of the text. Frequently the pictures, notwithstanding their imperfections, give a more exact idea of their subjects than the pretended descriptions by which they are accompanied. The last are, in fact, so fanciful that it is impossible to form a conception of the creatures to which they are supposed to relate. Thus, we may learn from them that frogs have only three feet, while lobsters are provided "with so great a number that the most patient man can not count them." The accounts of the habits of the creatures are even more fabulous than those concerning their structure. Some are said to live without eating ; some to increase by breaking into pieces ; and others to be able to live as well on the land as in the water.

Authenticated by the signatures of the disciples of Confucius, and by appearing in print, these fables are believed by the people more readily than even the observations they may make on the animals themselves The fanciful descriptions of three-legged frogs, made by a *literatus* who lived three hundred years ago, is to-day accepted by

all the Chinese who pride themselves on being in the least degree familiar with the classics. Thus, in spite of the protestations of the poor frogs, who gambol in their best style on the banks of the ponds to show everybody that they are planted on four feet, the Mongolian painters and sculptors, regarding the writings of the *literati* as oracles, persist in representing them with only three feet! But the painters, even the most violent partisans of the romantic school, do not allow themselves to amputate a limb except when dealing with a purely artistic work. For common scientific books, they do not give themselves the trouble to put on a surgeon's apron for so little, and it is on account of this indolence that the plates that adorn the works on natural history are more true to the representation of nature than the text they illustrate.

I was so fortunate as to find one day, in a curiosity-shop in Canton, an old album in which were represented, in fifty-two brightly-colored plates, the principal fishes of the southern littoral of the Celestial Empire, which I have studied with much interest. I can not undertake to describe all the plates here, but will limit myself to the accounts of the species which would be regarded with most attention by the inhabitants of the West.

One of them is a singular animal, shaped somewhat like a whale, but with a head so like a woman's that we have to believe that the artist, rather than Nature, has been indulging in a little fancy-work. The accompanying text informs us that it is a shark of the species "three women with a long tail" (*à longue queue des trois femmes*). It is one of the most remarkable of the numerous sharks of the Yellow Sea. The Chinese pretend that its head resembles a woman's, whence its name; then, they ascribe to it the power of the evil-eye, but only under particular circumstances. Thus, if they take a three-women shark in their nets, they think it a bad sign, and throw it back into the water to ward off the evil spirits. But, if they take one of these same sharks with a hook, they regard it as a good sign, and the poor animal pays with his life for the happy message he brings the ungrateful fisherman. Another plate represents a shark of the kind called bird-eaters. The animal derives its name from a fondness for winged flesh, which is in singular contrast with the habitual voracity of its congeners. In seeking to gratify its taste it lies upon the water as if dead. The sea-birds, taken by the trick, settle down upon what they think is a carcass out of which they can make a feast. When a sufficient number of them to give him a good taste have gathered upon his belly, Master Shark begins to sink his body slowly into the water, commencing with his tail, so as to drive his victims up to his head, and within reach of his capacious mouth. The whole operation, including the swallowing, is performed with such facility that we have to admire it at the expense of our sympathy for the victims of it.

The sharks play an important part in the life of the Chinese people, both of the coast and of the interior. The Yellow Sea is infested by

the numerous species, and has acquired a dreadful celebrity among the fishing and sailing population. In return, they pursue it with great ardor, and, thanks to its greediness in biting at all kinds of bait, with much success. The meat is eaten with relish, but the cartilaginous fins being much sought for by epicures, are too dear to be within the reach of the common people, and appear, along with bird's-nest soups and trepangs, only on the tables of the rich. The trepang, or holothuria, the third favorite viand of the Celestials, along with its concomitants, the sharks' fins and the bird's-nest soups, bears a very high price. Hardly any amount, even up to its weight in gold, is considered too great to pay for this exquisite dish, which, besides its delicate taste, is supposed to have the precious quality of assuring to those who eat it a numerous posterity. The animal, so great is the demand for it, is now rarely found in the Yellow Sea, but those which are consumed in the restaurants of Peking and Canton are brought from Australia and the Marianne Islands, and this fact goes to enhance their price. The holothuria-fishery is, moreover, a very difficult one. The animals live upon the rocks at considerable depths. The fishing is carried on by Malays, who go out in April or May in little boats, providing themselves with long rods armed at the end with a sharp hook that fills the office of a harpoon and a dredge. When the sharp-eyed fisherman discovers a trepang in the depths, he takes his rod and with a dexterous stroke sweeps the animal from the rock and lands it in the boat. The trepang-catchers are, however, much aided by the marvelous clearness and smoothness of the water in the regions where their game is found.

Chinese fishing-nets are made precisely like those used in the West, preferably of hemp; but, in very large nets, the silk of a wild silk-worm is used, to make them lighter and more manageable, as cotton is used by the Dutch fishermen. Before casting a new net into the sea, it is dyed a suitable color. For this purpose, it is dipped into a solution of mangrove-bark, to preserve it from rotting, and is then colored with hog's blood. The new net is then spread upon the beach; candles are lit, and tapers of paper and incense are burned about it, to secure the blessing of the Queen of Heaven. If the net is of cotton, maceration in oil takes the place of the dipping in the solution of mangrove-bark. The harpoons and the hooks are of iron, the lines of hemp, straw, and bamboo-fiber; and the boat-sails are also generally made of straw or bamboo-fiber, as Western canvases are still beyond the means of the fishermen.

Six kinds of boats are used, according to the nature of the fishery in which they are to be employed, the largest of which, the *ta-tsang*, requires a crew of six men. It is fifty or sixty feet long, and, like all the Chinese junks, is flat-bottomed, with square bow and stern. The rudder is rigged in a similar manner to those of our lighters, but is bored with round holes which let the water through and augment its

action on the ship. It is also capable of being moved up and down, so as to increase or diminish the extent of the submerged surface. In some junks, it can be let down below the bottom of the vessel, and this property permits the craft to be handled very rapidly, and within spaces in which our otherwise better ships can not turn. The *ta-tsang* is divided into close compartments, each of which has its particular use; and has two masts, one in the center and the other toward the stern, each carrying a square bamboo-leaf sail. The sails are furled by letting down the upper yard, but are difficult to manage in bad weather, on account of their large size; so that, when at sea, it is deemed prudent to carry only half-sail. These boats are within the reach only of the aristocrats of the sea. The boats of the common fishermen are much smaller and more manageable. The most curious among them is the one which is called the "white jump." It is a long shallop, drawing but little water, and furnished on one side with a broad board painted white, which is fixed so as to slope toward the water. The boats only go out in clear moonlight nights, when the light reflected from the white surface attracts the fish, and they try to leap upon the plank. But they usually leap too far and fall into the boat.

With their nets, hooks, harpoons, and "white jumps," the fishermen of Swatow and Ningpo capture so many victims that there would be danger of their being killed to no purpose, had not Chinese industry found a way to transport them for long distances, to where they may make regal repasts for epicurean mandarins. The fishermen of Ningpo preserve their catches in ice, which they manage, notwithstanding the mildness of the climate, to get made on the spot. The Chinese processes for making ice are servile imitations of those of Nature. The rice-fields are the factories. When the cold begins to be felt, the flats are covered, by the aid of pumps, with a very thin bed of water. The ice which forms during the night is broken up every morning by coolies, who carry it, carefully cleaned from adhering mud, to the ice-houses, and then flood the fields again. The ice-houses are simple in construction, but capacious; for the climate of Ningpo is too mild to permit ice to be formed every year, and the proprietors are required by law to store in them enough to last three years. The ice-house consists of a vast quadrilateral, inclosed in walls made of stones cemented with mud, rising some twenty or twenty-five feet above the ground. The faces of the walls are thickly plastered, and the whole is then covered with heavy bamboo-matting, which is supported by a framework also of bamboo. The ice-houses of the north are smaller and less solidly constructed, for thick ice forms there abundantly every winter, and is more easily kept through the summer. In the vicinity of the capital, the ditch which anciently inclosed its domain is still well enough preserved in some places to serve as an ice-pond, and the ice-houses are built near its banks.

The fishermen also require large quantities of salt, and this is

manufactured in a very simple manner by the primitive method of the solar evaporation of sea-water. The salt-factory consists of a large terrace, above which is another terrace of only one sixth the superficial area of the lower one, and of two salt-water cisterns, one at a short distance from the terraces, and the other between them. The terraces having been covered with a bed of gravel, the larger or lower one is filled with water, which is admitted at high tide through a sluice-gate in the dike. After giving a sufficient time for the soil of the terrace to absorb the water, the gravel, on which a considerable quantity of salt has accumulated, is raked up. At a little above the level of one of the cisterns is fixed a filter made of bamboo rods. On this is piled the salted gravel which has been collected from the lower terrace, and through the whole is run a stream of sea-water from the larger cistern. The water, having absorbed the salt from the gravel over the filter, is then led into the smaller cistern—the one between the terraces—and from this is taken and spread over the second terrace, where the solar heat soon removes it by evaporation from the dissolved salt. The salt is then ready for use without any further preparation. Two men are sufficient to work a salt-bed that will furnish an average of seven hundred and twenty kilogrammes of salt every two days—a return that would be extremely profitable were it not for the taxes. But the manufacture of salt is a government monopoly, and whoever goes into the business has to pay the state seven tenths of all that he produces; so that the road to wealth, for the individual, is not, after all, through a salt-marsh.

Busy as he is at his busy time, the Chinese fisherman's life is a hand-to-mouth existence, and it is a great strain upon him to maintain himself through his dull season. Men of this craft have then to resort to other side-trades to eke out their living. Some of them gather up shells on the beach and burn them into lime; some split off the nacreous parts from large muscle-shells and carve them into square semi-transparent panes, which serve as substitutes for window-glass; and others, going to the oyster-beds, skillfully pry open the shells so as not to disturb the inhabitants, and slip into them pieces of wood carved into fanciful shapes, which will in time become thinly covered with nacre and be sold for mother-of-pearl ornaments.

In view of the precarious condition of their existence, the fishermen have formed themselves into societies for common protection against the rapacity of the mandarins and to give assistance to such as may be in need. The society at Haï-Meun constitutes a strong corporation, and possesses a large building, where its business meetings are regularly held and theatrical representations are given; a hall for the public weighing of such fish as are sold by weight; and a temple where sacrifices are made before going to sea, with a space in front of it in which the new nets are spread for the performance of the ceremonies of consecration.

Mr. J. Duncan Campbell, of the Chinese Marine Customs in London, said in an address, in 1881, that "without any acquaintance with the laws of capital and labor, the Chinese fishermen have come to a practical solution, satisfactory to all of them, of the question of co-operation in benefits." This agrees with my own conclusions, and is accurately true of the large masses of fishermen living around Swatow. These fishermen are formed into labor-unions, which are important according to the scale of fishing in which they are engaged. The most considerable companies are those which employ the *kaio-kou*. Each of them controls two large junks (*kaio-kou*) having crews of fifteen men each, and forty-five shallops carrying usually three men each; making in all forty-seven boats and one hundred and sixty-five men. Each company is directed by a chief, who has under his orders a steward to keep the accounts and attend to the sales. The systems for dividing the proceeds are different in different places and with different companies. In one of the companies each 10,000 francs is divided as follows: 1,800 francs for the hire of the boats and the fishing-implements, which are let by a capitalist; 250 for the expense of religious sacrifices; 300 for the salaries of men under employ who do not belong to the company; 400 for the helmsman; of the remaining 7,200 francs, half to the captain, and the rest equally among the men of the company. In the smaller companies, which usually employ only shallops, the proceeds are commonly divided into fifteen parts, six of which go to the captain, two to each of the four men of the crew, and one is applied to the sacrifices. Some companies give thirty per cent to the capitalist who furnishes the ship, seven per cent to the chief of the company, four per cent to his steward, seven per cent to each of the junks, and one per cent to each shallop. The boats divide their shares into as many parts as there are men in the crew, *plus* one, and that goes to the helmsman, who always has two parts.

The river-fisheries are not so lucrative as those of the sea, and less generally give employment to a class of professional fishermen. The tackles used in carrying them on are not essentially different from those employed in similar kinds of fishing in Europe. In the more important river-fisheries, however, two auxiliaries are employed that are wholly unknown in Western fishing—the otter and the cormorant. The otter, which is frequently met in the Blue River, is trained to drive the fish into the nets, and does it as dexterously as the best hunting-dogs bring the coveys within reach of their masters' fowling-pieces.

The cormorant does all the work of fishing for his master, who only has to take care of the boat. The birds stand upon the edge of the shallop till the boatman gives the signal, when they spring into the water to perform their task. As soon as they have captured a large fish or filled their throat with smaller ones, they return to the boat and their master takes possession of the prey. If they find a fish too

large for one bird to take care of it alone, two or three of them will join to assist in bringing it in.

The cormorants are trained for their business with great care. The most intelligent birds are said to come from the province of Che-Kiang. The eggs of the first spring laying, which usually takes place in February, are collected and put under hens, the maternal love of the cormorant being only feebly developed. The young when first hatched, being extremely weak and delicate, and prone to succumb at the slightest chill, are put into wadded baskets, where they can be kept at a uniform temperature. They are fed with pellets of beans and finely chopped eel, till at the end of a month, when, having become nearly covered with feathers, they are given the eel alone; at the end of another month, they are able to eat small fish whole, and are worth five dollars a pair. When they have got their growth, which is about five months after they are hatched, they are tethered by a string tied around the foot on the banks of a stream or a pond. The trainer, stirring the water with a pole, and whistling an air which the birds learn is the signal for "take to the water," throws in some small fish, which they attack with all the more voracity as they have not been too well fed. The trainer then whistles another air, which is to be the signal for coming back, and, that the birds may not be mistaken as to its meaning, he pulls at the same time upon the cord that holds them. These lessons are continued for two or three months, when the scene of the practice is changed to the boats; and at the end of another month the cord is dispensed with. There are, of course, differences in the capacity of cormorants as well as of men. While the stupid ones are sent to the pot, the most sagacious and best trained male birds are worth seven or eight dollars apiece, females less. The period of service of the cormorants is short. They begin to lose their feathers and to go into decrepitude in their fourth year, and generally die before they are six years old. Whether this brevity of life is due to the peculiar style of feeding the birds, or is one of the inevitable attendants of domesticity, is not known; for we have no authentic information respecting the length of life of cormorants in a wild state.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE ACCURATE MEASUREMENT OF TIME.

By THEO. B. WILLSON.

THERE are few people who have much knowledge of the present state of the science of measuring time. This is probably owing to the scarcity of sources of information on the subject, for almost every one has more or less interest in it. One might naturally suppose that his jeweler could discourse intelligently, if not profoundly,

on such matters; but he is a very exceptional man if he has any considerable knowledge of the principles underlying the construction of the most common chronometers, so far as they employ principles not found in common clocks. In illustration of this ignorance of the subject, even among workmen who are thoroughly competent to treat all the disorders of time-pieces properly, and that to the degree of constructing broken or missing parts, or of mending fractures so nicely as to leave no trace of a break, the following instances may be given:

The clock most commonly used by the watch-makers as a "regulator" is one with what is called a "gridiron" pendulum. This consists of nine brass and steel rods, side by side, with their couplings so arranged that, in the changes of temperature, the variation of the brass counteracts that of the steel. Now, it is the fact that a large per cent of these pendulums are simply false "gridirons," while a very small per cent of the watch-makers are able to tell the difference. One might suppose that the running of the clock would reveal this at once. But it should be remembered that the variations of a clock on account of temperature are very slight. An abrupt change of ten degrees maintained through twenty-four hours will cause a seconds pendulum to vary but a little over two seconds. Bearing in mind, then, that a pendulum may be timed to a mean temperature, and that thus the variations would tend to equalize each other; that, if the clock should thus come within a second a day, it would satisfy most watch-makers; and that as a matter of fact they ordinarily do change their "regulators" several times a year—we have little difficulty in accounting for the wide-spread ignorance of theory among them. To this may be added the consideration that there is no money in knowing about these things, and that to know about them takes time that might become money.

Again, we shall find our jeweler almost equally ignorant of the principles of compensation in the balances of watches. There are but few of them, indeed, who can not tell the genuine balance from the spurious, but there are hundreds of them who could not state, if life depended upon it, why the brass must needs be on the outside and the steel inside in such a balance, or why the converse arrangement would not be equally good, or whether the screws in the rim have anything to do with the compensation.

If, then, those who might be expected to know know so little, where shall we look for information? In view of the general ignorance of this matter and interest in it, a plain and untechnical account of the difficulties in the way of measuring time accurately with clocks or watches, and the progress that has been made in obviating them, may be profitable.

The whole matter of the accurate measurement of time turns, of necessity, on the manner of controlling the rate of escape of the mechanism which indicates the time. Thus far there are only two

devices which have been found to do this with anything like accuracy, the pendulum and the balance-wheel. Postponing, for the present, the discussion of the balance-wheel, we have before us the pendulum.

That the pendulum might be used for the measurement of time is a discovery which dates back, at least, to the time of Galileo. A great many, even among well-educated people, suppose that that philosopher discovered that a pendulum of a given length will always oscillate in the same time. This he could not have discovered, for it is not true. The correct statement of the law he discovered is, that a pendulum will always oscillate in the same time through equal arcs, but not through any arc. It has been found that if the curve in which a pendulum swings were a portion of a cycloid instead of a circle, and the pendulum were simple, that is, consisting of a bob or ball suspended by means of a thread imagined to have no weight, its oscillations would be in equal times through any arc. To accomplish this, clocks were at one time made with pendulums which were suspended between cycloidal cheeks, and were thus conformed, in swinging, to the cycloidal curve. But this was soon abandoned, as it was found that it was impossible to construct such cheeks without variation or imperfection sufficient to make a greater error in the pendulum than it would have if allowed to swing on a circular arc. For a short distance the cycloidal curve corresponds quite closely to the circle. Therefore, by adjusting the pendulum to swing but a short distance, it was found to be possible to secure substantial uniformity. This is the plan now universally adopted.

If the arc of vibration is increased, the clock will lose time. Experience with the common house-clock would seem to contradict this, for every one has noted that when the clock is first wound it will gain time, and then that it will lose as it runs down, and, seemingly, this is due to the difference in the swing of the pendulum. The explanation, however, is to be found in the fact that in case the pendulum swings farther it is shortened by the curving of the spring by which it is suspended, and also by an effect which the longer swing is found to have upon the escapement, quickening its time. Any ordinary house-clock would keep far better time if the weight of its bob were considerably increased, as this would do much toward equalizing its swing. Ordinarily the weight of the bob is about three ounces; if the clock is properly put in beat it will carry a bob weighing as many pounds, and all spring-clocks would be greatly improved as time-keepers by such a change. If this is true, some one may ask, Why is it not made by the manufacturers? The answer is, that any firm who should put such clocks on the market, superior time-keepers as they would really be, would soon find themselves getting the reputation of making a clock that would not run, and all because the public generally would not have the skill or the patience to adjust the beat properly. Let a servant, for example, take such a clock to her room

at night, with the alarm set to call her up to get the family's breakfast. She sets the clock on an uneven table, and in a short time it will stop, and the girl will not be alarmed in the morning, except on discovering that the clock has stopped, and that she has far overslept herself. Thus, to make a sure clock, the manufacturers must make a poor one. For the best running of a fine clock it has been found that about twenty-seven pounds is the most satisfactory weight for the bob.

If it were not for what may be designated as meteorological changes, the problem of the accurate measurement of time would be solved if we had a heavy pendulum driven uniformly over a small arc. But here are two "ifs." We will take the second of them first, as it is more easily disposed of. Postulating at the outset machinery in the train very nicely executed, and with jeweled bearings so that it will act uniformly, or with the least possible variation, we have before us the question of propelling it uniformly. That the best power for a clock is a weight, is beyond dispute. The invention of the coil-spring came near annihilating the race of good common clocks. "Grandfather's clock," with its wooden wheels and other crudities, is still the superior of the grandson's clock as a time-keeper, for "grandfather's clock" had the great advantage of a uniform power sufficient and just sufficient to propel the clock when it was properly cleaned and oiled. The grandson's clock has a coiled-spring as a motive-power, having, when it is tightly wound, not less than three times the amount of power required to drive the clock, and diminishing in amount, thereby altering the rate of the clock, with each successive hour. The grandson's clock will march on, oiled or unoiled (and therefore usually unoiled), until it comes to a premature end as complete as that of the "one-hoss shay." The "grandfather's clock," on the other hand, which declined to go unless its rations of oil were doled out to it once in a year or less by the peripatetic tinker, is good for another century, since its bearings have been saved from cutting themselves away from lack of oil. The kitchen-clock of to-day can only be made to keep respectable time by so regulating it that the gain it makes when tightly wound shall be offset by the loss as it runs down. Something is gained in spring-clocks by resorting to the fusee—a device which maintains the power of the spring as it unwinds by giving it a greater leverage. This device was much employed by the makers during the early days of spring-clocks; but it was found to be so difficult a matter to secure a chain or cord for the connection that was reliable that the plan has been almost, if not altogether, abandoned. About the only opportunity of seeing a fusee to-day is in an English watch. It has been abandoned by watch-makers in America and in Europe, outside of England, so that the modern watch has no chain, and is made to go uniformly by adjusting to "isochronism," as it is called, which will be explained later.

Assuming that the power for an accurate clock must be a weight, we are ready to pass to the application of this power to the propelling of the pendulum, save this one consideration, that, unless there is some special provision, the clock will not advance while it is in process of winding. This provision is made in fine clocks by means of what is termed a retaining-click—an ingenious contrivance which brings the power of a small spring to bear while the key withdraws the power of the weight. This device is also found in the English—that is, the fusee-watch. Other watches need no such contrivance, for, as one end of the spring is fast upon the winding-post and the other upon the outside of the barrel, winding tends rather to stimulate and not to stop its going. The same is true of marine clocks. But common pendulum-clocks have the outer end of the spring attached to the frame of the clock, and hence the application of the key takes off the power, and the scape-wheel does not advance while the clock is in process of winding.

Supposing ourselves now possessed with a uniform power, uniformly applied to the scape-wheel, the problem arises as to the mode of communicating the power of the scape-wheel to the pendulum, in such a way as to sustain its beat, but not affect the time of it. Without going minutely into the discussion of the escapement, it may be remarked that there are two current forms of it. One of them is termed the "recoil" escapement, and its peculiarity is that it at no time arrests wholly the power of the scape-wheel—that is, it recoils by its own action after a tooth has passed one side of the verge, and returns toward the other beat. This is the escapement of the common kitchen-clock, and the chief objection to it is that, according to no definite law, the swing of the pendulum is made more rapid when the power of the spring is increased, as by winding.

A better escapement by far, and the one used in fine clocks, is the "dead" escapement, of which the characteristic is that, after it makes one beat, the pallet must be thrown off by the return of the pendulum before the scape-wheel can again apply its power. An example of this may be found in the ordinary marine clocks as well as in most watches, in which the lever is at rest after the balance has been thrown in one direction, until the return of the balance again trips it, and then its power is applied in the opposite direction.

This is found to be a satisfactory escapement for fine clocks which are not to be disturbed by any outside influences, but, for tower-clocks, which are affected by the wind, still another form is employed called the "gravity," or "remontoire" escapement, the principle of which is that the power of the clock merely lifts a small weight which is then unlocked by the swing of the pendulum and falls upon it, applying the uniform amount of its weight to propel the pendulum. There are, of course, two such small weights lifted alternately at each beat of the pendulum. The pendulum, therefore, has nothing to do with the

scape-wheel except to unlock it. Absolute uniformity can be secured by this device, as the variations of the clock's power are not felt by the pendulum.

We come naturally now to the problem of maintaining an invariable length of the pendulum in spite of atmospheric changes. There is no substance known which does not expand in the case of a rise in temperature, and *vice versa*. It has been found, however, that white deal wood varies, with the grain, but very little, and hence it is employed in many of the better class of clocks, as being better than a cheap and imperfectly constructed compensating pendulum. Still, this does not give full satisfaction, as other changes, such as that from moist to dry, do affect it in a degree; and hence pendulums have been devised in which the variation of one metal is counteracted by the variation of another in the opposite direction.

The most common form in which we see such pendulums is the so-called "gridiron," which takes advantage of the greater sensitiveness of brass than of steel to changes in temperature. It is made with nine bars of brass and steel alternately arranged, the total length of brass employed being to the steel inversely as the two metals are affected by changes of temperature. It is constructed so that the brass lifts the bob in case of a rise in temperature as much as the steel lets it down. To illustrate the principle of it, imagine a simple pendulum rod of steel; to the bottom of this fix a rod of brass slightly shorter than the steel one, letting it extend upward parallel with it; let a second steel rod now be affixed to the upper end of this brass one, also parallel to the others, and to the lower end of this attach the bob. We have now a gridiron pendulum, but one in which the amount of brass is not sufficient to counteract the changes in the steel. Before it will do this, we must make one more journey up with a brass rod and down with a steel one, affixing on this the bob. To construct such a pendulum it is found necessary to duplicate the first four rods; hence the nine that we always see. The genuine "gridiron" is a pretty good clock, but it is so often spurious that this kind of clock is going out of favor.

A third common device is the mercury pendulum, consisting of one or more cylinders filled with mercury to such depth that the movement of the highly sensitive mercury in the bob will counteract that of the entire rod. This is readily understood by viewing the center of the mercury as the center of oscillation (which it is very nearly), and imagining that the temperature rises. Of course, this center is carried upward half as much as the surface, and so great is the variation in the case of mercury that a vessel of it about six inches deep will counteract the steel rod of a seconds pendulum. This is the pendulum employed for fine astronomical clocks, and all jewelers who can afford them have them for regulators. The only objection to this pendulum is that the mercury, owing to its mass, is not affected by a change of

temperature quite so promptly as the slim rod of the pendulum. But this is not found to be a serious matter.

Of late, zinc has been coming into use in the construction of compensating pendulums. The best tower-clocks now all have zinc pendulums. The principle and the application are the same as in the "grid-iron," but the higher sensitiveness of the zinc simplifies the construction to such an extent that, only one return-rod of zinc being called for instead of two, as in the case of the brass, it can be made in the form of concentric tubes, and thus appear as a simple rod.

Such are the principal devices for securing compensation. There are many other ways of reaching the same end, and patents have been issued for ingenious designs, no one of which, however, has come into general use.

But, even with a pendulum compensated with brass, zinc, or mercury, we have not yet conquered the problem of measuring time with great accuracy, for, aside from the practical difficulties of obtaining homogeneous material and getting the proportions of the metals exact, there is yet to be taken into account another cause of variation which one could only be convinced by demonstration is capable of having any appreciable effect. It is that of atmospheric pressure. It has long been known that clocks vary somewhat with the barometer; and, of course, we see that they must, when we remember that a heavier or denser atmosphere tends to decrease the gravity of all objects—to bear them up, as it were—and hence, when the barometric pressure is greater, a clock will run slower. To counteract this, a magnet is resorted to, which is made to approach or withdraw from the pendulum by means of the rise and fall of the barometer. This is placed, of course, below the pendulum, and if nicely adjusted will keep the weight of the pendulum uniform.

If all the above disturbing elements are met by counteracting expedients, we now have a clock which will theoretically run without variation, provided it is once brought into the proper beat. A thumb-screw at the bottom of the bob will accomplish this approximately, but, to do it with the greatest accuracy, it is necessary to have a little cup suspended on the pendulum-rod near its upper end, into which one can drop some small weights, as shot, quickening the variation thereby, since it is a virtual raising of the center of oscillation. Fine astronomical clocks usually have this cup, and the best turret-clocks also.

It is at this point interesting to inquire how closely a clock, constructed in observance of all these principles, can be made to run. Generally speaking, it may be replied that it is a pretty good regulator which can be depended upon for a variation of less than a second a day, through all weathers, despite what is claimed for them by their owners. A distinction must be made between a uniform variation and keeping a mean time. I have a common eight-day spring-clock which does not seem to vary a half-minute in a month. This is, per-

haps, better than many regulators do; but, while it does not make an average variation of a second a day, it is far enough from making an actual variation of less than a second a day. Something better is obtainable from the very best astronomical clocks, which, indeed, are found to keep a uniform rate, from which they will vary only three or four hundredths of a second daily. But astronomical clocks, as is well known, are not required to indicate the exact time, mean or sidereal, but only to go at a uniform rate, which, if it be found to be practically invariable, is corrected at the time of the observation in which it is employed. The most accurately running large clock in the world, which has been regulated to keep diurnal time, is the Westminster clock in England. When the contract for the building of that clock was given out, it was stipulated that it must come within a second a day. It, in fact, does much better than this, for it is found that its variation is usually less than a second a week. It telegraphs its time daily and automatically to Greenwich, and the astronomer royal has said of it, "The rate of the clock is certain to much less than a second a week."

The other practical method of regulating the escape of a timepiece is through the balance-wheel, which, of course, must be resorted to in case of watches, ship-chronometers, and all clocks which are to be moved or carried about.

The method of regulation now in use in the watch is the result of long study of ingenious men. Starting with the discovery of the balance-wheel, carried back and forth with a diminishing oscillation by means of the hair-spring, we have before us the question of how to unlock the scape-wheel with each swing of the balance. In hunting through all classes of watches which find their way into the jeweler's refuse-box, after having served out their period of usefulness, we shall not be likely to come upon more than three (and certainly not more than four) styles of escapement. The oldest watches in the box will have what is termed the horizontal or barrel escapement. This is the escapement of the so-called "bull's-eye" watch of our grandfathers. These watches always had a great reputation as time-keepers, yet I presume it is safe to say that there never was one in existence which could be relied upon to keep within a minute a day in the pocket, and most of them needed a much larger allowance. This escapement had a small wheel, with its axle parallel with the plates of the movement, and its teeth acted upon the pallets, which were little, flag-like appendages to the staff of the balance, and set at right angles to each other. The chief defect of it was, that a slight variation in the power, acting directly as it did upon the balance, affected very materially the rate of the watch. So that, while our grandfather's clock was even a better time-keeper than clocks of the same grade manufactured to-day, our grandfather's watch is not to be named in comparison with the cheapest modern watches.

The second class of escapements which we shall find exampled in the waste-box is called the cylinder escapement, which still continues to be used in some of the cheaper Swiss movements in boys' watches, and such as the ladies wear suspended from the belt. It is the most compact escapement which has ever been made, and is employed in such very small specimens of the watch kind as are made to be set in the head of a pencil, a shirt-stud, etc. It is by far the most reliable escapement except the lever. Its principle is that the cylinder of the balance-wheel is so cut that each tooth of the scape-wheel must force it partly round to get past it. While it is making this turn, the next tooth of the scape-wheel is caught upon the blank side of the cylinder, and held until the recoil of the hair-spring brings the balance back.

Here and there a specimen is to be found of the old "duplex" escapement to which the modern "Waterbury" is allied. It is so rare as hardly to need our consideration. It is a good escapement when in order, but is rather liable to get out of order.

A third form of escapement, and the one now in use almost universally, is the detached lever. There are patent levers, straight-line levers, and various other levers, but they are all detached levers, for the reason that there is one point, in the course of each swing of the balance, when the lever is entirely free or detached from the balance-wheel, and so stands until the return-swing unlocks it. It is difficult to conceive of anything that would be an improvement upon this, and seemingly no improvement is needed.

Before we pass from the consideration of the escapement to that of the balance itself, a remark should be made as to the relative advantages of different rates of escapement. It is found that up to a certain point what is called the quickness of the train, or, in plain English, the rapidity with which a watch beats, makes a difference with its qualities as a time-keeper. This seems to be owing to the fact that where a watch beats more slowly it is more apt to lose an occasional beat through the jar and tossing about in the pocket. The Swiss manufacturers took the lead, and have for forty years or more made quick-train watches, beating five times to the second, or eighteen thousand times to the hour. The English watches commonly beat four times to the second, or fourteen thousand four hundred to the hour. American watches are made with the quick train of the Swiss, but more commonly with a beat intermediate between the two extremes. It is curious that the English, who have given so much money and thought in the past to the manufacture of time-pieces, do not to-day make a good watch nor a good common clock. Their adherence to the slow train is one of the reasons of their failure in watches, and their retention of the fusee is another. So great has been the decline in the English trade in watches and clocks, that a number of their experts in that line recently recommended petitioning the Government to cause an official investiga-

tion to be made to learn its causes, and what can be done to arrest it and restore the trade.

Perhaps we ought yet to pause, before taking up the balance itself, to take note of a form of escapement employed in chronometers (using the word in its strict sense as applied to clocks which may be moved, but must not be jarred or tossed about, and are to remain in nearly the same position). In this escapement the tooth of the scape-wheel acts directly upon the balance, and after so acting is caught upon a shoulder, from which it is only released by the return of the balance. Better results have been obtained with this than with the detached lever for chronometers, but it is not so good for watches, as it will not bear violent and sudden tossing about into all positions.

To measure time accurately with a balance-wheel, three sources of variation must be overcome—that is, the balance must be adjusted to heat and cold, to position, and to "isochronism," as it is termed—that is, it must in some way counteract its own variation, due to temperature as well as that of the hair-spring; its bearings must be so cut or shaped that changes of position will not occasion unequal friction; it must be made to beat uniformly, in spite of the variations in power which result from doing away with the fusee.

The method of compensating a balance is to-day everywhere the same. A compensated balance consists of a bar of steel, to the opposite ends of which are attached semicircular bows of brass and steel soldered together, the brass outside, and into these bows are screwed what are termed "set-screws." It will be seen that, in case of a change for the warmer, the brass outer rim will expand more than the inner steel one, in each of the arms, and that this will throw the extremities of the arms in toward the center, thus compensating, if the proportions are right, for the general expansion of the balance; and *vice versa* in case of a change for the colder. Of course, it is a very nice piece of experimentation which ascertains these proportions. After the approximate proportions are secured, the exact ones are obtained by means of the screws in the rim. Compensation in a balance-wheel is of far more importance than in a pendulum, for the variation of the rate of the time-piece, if not compensated, is far greater. And this is due not only to the expansion and contraction of the balance, but also to the variation in the power of the hair-spring under various temperatures, as above remarked.

I may pause to note that here is one of the tests of a watch that any one may resort to. There are many imitation compensating balances which look very like the genuine, save that they have not the cut, or have only a notch at the extremity of the bow, so that the bow is not free, and, of course, there is no compensation.

After a watch has been adjusted to heat and cold, it must be adjusted to "position"—that is, so that its rate will not be altered by changes of position. This is a nice piece of work. It is accomplished

by shaping the pivots, blunting them or sharpening, according as it is found to be necessary.

The third difficulty named was that of preventing the different pressures of the mainspring (as when it is tightly wound or nearly run down) from altering the rate of the watch. This is effected in the following manner: It is found to be a fact that there is a point in any hair-spring at which, if it be secured, it will carry the balance-wheel at the same rate no matter what the force of the train. This point can only be discovered by experiment, and the discovery of it constitutes the adjustment of the watch to what is called "isochronism." By continually shifting the point where the hair-spring is pinned, a point is finally discovered where the watch goes at a uniform rate, which may be too fast or too slow, but it is uniform. This point ascertained, the watch is then made to keep diurnal time by shifting the screws in the circumference of the balance.

Of course, it greatly increases the expense of a watch to add these fine touches by the best skilled workmen; and yet so perfect is the machinery to-day and so closely does the watch when first put together conform to the well-understood proportions that in point of fact a large per cent of them are found to be correct, and need little or no adjusting. In this case they are simply marked "Adjusted," and sent to market. The leading American factories have discontinued the manufacture of watches which have not compensating balances, so that, even though the watch be of cheaper grade, it will still run far better through all weathers than the best watches with a solid balance.

In the American watch we may well take a patriotic pride, for it is the best watch in the world; and, what is more, it is being imitated everywhere. Its only real rival is the Swiss watch, the better grades of which can hardly be said to be inferior as time-keepers to American watches. The cheaper grades, however, will not rank with the same grades of our watches.

After a watch has been given all the advantages of adjustment described, it is interesting to inquire how closely it will run. But, lest we expect too much, it is important that we keep in mind that a watch is at great disadvantage in comparison with any other time-keeper, for it can depend upon no uniformity either of rest or of motion. No two men's habits of life are such as to give their watches exactly the same jar and disturbance. One man's watch is laid down at night, and another's is hung up; one man's is in the cold, and another's is where it is warm; one man is much upon the rail, and another seldom travels at all; one man's habits of life take him into those sorts of dust which soon clog the oil of his watch, another is never in any dust. Add to all these considerations one more, namely, that a watch will run a little freer, and hence a little faster, when the oil is fresh, and of course will slow down as the oil gets old, and we

have abundant reason for great leniency in judging of the work of these really marvelous machines.

Remembering these things, we shall be prepared to accept the stories about the wonderful running of some watches with more or less allowance. That watches sometimes seem to go with very slight variation for long periods of time is often accounted for by the fact that the accelerating and the retarding effects in the carrying of them have nearly counterbalanced each other. A good watch may be so nicely regulated as to keep a mean time between its variations, which will be very accurate. I have heard of two watches in the course of my life for which their owners claimed that they varied only four seconds a month, and I can not help adding that they sought to touch the regulator just once more to overcome even this variation. With one of these men I had a personal interview, and succeeded in drawing out that, after all, he was not telling what his watch varied, but only how it stood at the end of a month; for aught he knew, it might have ranged a minute or two either way during the time. The other man I never met; but I trust these are the only men in the world who ever imagined that a pocket time-piece can be made to have a uniform variation of less than a second a week. But such men serve as an example of the misfortune it really is if one possesses too good a watch. When a man gets to reading the time on his watch by the second-hand, he is likely to feel discouraged and out of joint with the world much of the time, for his watch will not bear such scrutiny. A far happier man is he who can only afford a poor old "turnip" which, like Sam Weller's, must be set twice a day. A man who possesses one of these wonderful watches, supposed to run to the second, could hardly feel worse to find himself coming down with the cholera than to find that without seeming provocation his watch has gained or lost twenty-five seconds.

I add a few remarks upon the use and care of time-pieces, their visits to the jeweler, etc.

It is to be observed that there are many unscrupulous men working at the bench who have very little real knowledge of their trade, and who, to make a living, must make the most of what they get to do. Such men uniformly declare that any watch which comes into their hands to be repaired needs cleaning, which will cost you from a dollar to a dollar and a half. Sometimes this is true, and sometimes it is not. If you have a stem-winder in a close-fitting case, it is probably not dirty, and yet, if it has run two years or so, it ought to be oiled. This most jewelers will do, if you ask them to, for a small fee. If I owned a fine watch, my practice would be to take it to a jeweler, and have it thus oiled once a year, having it cleaned perhaps once in three.

If a jeweler tells you that there is some very serious trouble or break in your watch, which it is going to cost several dollars to get repaired, ask him to take the watch "down," as he terms it, and let

you see that trouble. An honest man, not overdriven, is always ready to do this.

It is a little better to wind one's watch in the morning than at any other time, since, if you wind at night, and then expose your watch to the cold, the chilling of the mainspring is more apt to break it when tightly wound.

Empty out the dust that accumulates so quickly in your pocket often; it will save your watch from the unnecessary contact and battle with dirt.

It is amusing to hear an ignorant customer betray a fear lest a jeweler shall steal some jewels from his watch while it is in his possession. A friend of mine, who is a jeweler, in such cases always reaches for his bottle in which he keeps his watch-jewels, and asks the customer to hold his hat while he turns them in. This usually brings the customer to his senses. In point of fact, a large part of the jewels in common watches are nothing but glass. Next comes aqua-marine or beryl, then garnet, then ruby, and rarely sapphire. But even a ruby-jeweled watch is a very rare commodity; and even these rarer stones would be of very little value for any other purpose, perforated as they are for the pivot; and the fear lest the jeweler may steal them is simply ludicrous.

There is an amusing superstition, which has not as yet wholly disappeared, that a watch ought not to be turned backward. I hardly need remark that this is wholly groundless, for the "cannon-pinion," as it is called, that carries the minute-hand, is wholly independent of the train, and merely rests upon the prolonged pivot of one of the train-wheels, on which it turns with slight friction; and, indeed, if it should fit too closely, it would be more likely to damage the watch if it were turned forward than backward. The same thing holds in case of a clock, of course, save that, in case of a striking-clock, a backward turn after the "snail" has unlocked the striking-gear, and the clock is about to strike, will cause it to do so, and hence it will strike wrong. And, of course, after it has struck in the ordinary way, it can not be turned back far without the snail's catching on the outside of the lifting-wire. This will make it impossible to turn it back farther. But no turn will in any way injure the clock.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XLVI.—THE COOKERY OF WINE-DRYING.

THE reader will understand, from what has already been stated concerning the origin of the difference between natural sweet wines and natural dry wines, that the conversion of either one into the other is not a difficult problem. Wine is a fashionable beverage in this country, and fashions fluctuate. These fluctuations are not accom-

panied with a corresponding variation in the chemical composition of any particular class of grapes, but somehow the wine produced therefrom obeys the laws of supply and demand. For some years past the demand for dry sherry has dominated in this country, though, as I am informed, the weathercock of fashion is now on the turn.

One mode of satisfying this demand for dry wine is, of course, to select a grape which has less sugar and more albuminous matter, but in a given district this is not always possible. Another is to gather the grapes before they are fully ripened, but this involves a sacrifice in the yield of alcohol, and probably of flavor. Another method, obvious enough to the chemist, is to add as much albuminous or nitrogenous material as shall continue to feed the yeast-fungus until all, or nearly all, the sugar in the grape shall be converted into alcohol, thus supplying strength and dryness (or salinity) simultaneously. Should these be excessive, the remedy is simple and cheap wherever water abounds. It should be noted that the quantity of sugar naturally contained in the ripe grape varies from ten to thirty per cent—a very large range. The quantity of alcohol varies proportionally when the must is fermented to dryness. According to Pavy, "there are dry sherries to be met with that are free from sugar," while in other wines the quantity of remaining sugar amounts to as much as twenty per cent.

White of egg and gelatine are the most easily available and innocent forms of nitrogenous material that may be used for sustaining or renewing the fermentation of wines that are to be artificially dried. My inquiries in the trade lead me to conclude that this is not understood as well as it should be. Both white of egg and gelatine (in the form of isinglass or otherwise) are freely used for fining, and it is well enough known that wines that have been freely subjected to such fining keep better and become drier with age, but I have never yet met a wine-merchant who understood why, nor any sound explanation of the fact in the trade literature.* When thus added to the wine already fermented, the effect is doubtless due to the promotion of a slow, secondary fermentation. The bulk of the gelatine or albumen is carried down with the sediment, but some remains in solution. There may be some doubt as to the albumen thus remaining, but none concerning the gelatine, which is freely soluble both in water and alcohol. The truly scientific mode of applying this principle would be to add the nitrogenous material to the must.

I dwell thus upon this, because, if fashion insists so imperatively upon dryness as to compel artificial drying, this method is the least objectionable, being a close imitation of natural drying, almost identical; while there are other methods of inducing fictitious dryness that are mischievous adulterations.

* The wine-trade has two rival magazines, both very high-priced, exclusively devoted to its interests, besides others that are partially so.

Generally described, these consist in producing an imitation of the natural salinity of the dry wine by the addition of factitious salts and fortifying with alcohol. The sugar remains, but is disguised thereby. It was a wine thus treated that first brought the subject of the sulphates, already referred to, under my notice. This, although sold to my friend at a good price, was a concoction of the character known in the trade as Hambro' sherry. It contained a considerable quantity of sugar, but was not perceptibly sweet. It was very strong and decidedly acid; contained free sulphuric acid and alum, which, as all who have tasted it know, gives a peculiar sense of dryness to the palate.

The sulphuring, plastering, and use of Spanish earth, described in my last, increase the dryness of a given wine by adding mineral acid, and mineral salts. In a paper recently read before the French Academy by L. Magnier de la Source ("Comptes Rendus," vol. xcviii, page 110), the author states that "plastering modifies the chemical characters of the coloring-matter of the wine, and not only does the calcium sulphate decompose the potassium hydrogen tartrate, with formation of calcium tartrate, potassium sulphate, and free tartaric acid, but it also decomposes the neutral organic compounds of potassium which exist in the juice of the grape." I quote from abstract in "Journal of of the Chemical Society" of May, 1884.

In the French "Journal of Pharmaceutical Chemistry," vol. vi, pp. 118–123 (1882), is another paper, by P. Carles, in which the chemical and hygienic results of plastering are discussed. His general conclusion is that the use of gypsum in clearing wines "renders them hurtful as beverages"; that the gypsum acts "on the potassium bitartrate in the juice of the grape, forming calcium tartrate, tartaric acid, and potassium sulphate, a large proportion of the last two bodies remaining in the wine." Unplastered wines contain about two grammes of free acid per litre; after plastering, they contain "double or treble that amount, and even more."

A German chemist, Griessmayer, and, more recently, another, Kaiser, have also studied this subject, and arrive at similar conclusions. Kaiser analyzed wines which were plastered by adding gypsum to the must, that is to the juice before fermentation, and also samples in which the gypsum was added to the "finished wine," i. e., for fining, so called. He found that "in the finished wine, by the addition of gypsum, the tartaric acid is replaced by sulphuric acid, and there is a perceptible increase in the calcium; the other constituents remain unaltered." His conclusion is, that the plastering of wine should be called adulteration, and treated accordingly, on the ground that the article in question is thereby deprived of its characteristic constituents, and others, not normally present, are introduced. This refers more especially to the plastering or gypsum fining of finished wines (Biedermann's "Centralblatt," 1881, pp. 632, 633).

In the paper above named, by P. Carles, we are told that, "owing

to the injurious nature of the impurities of plastered wines, endeavors have been made to free them from these by a method called 'deplastering,' but the remedy proves worse than the defect." The samples analyzed by Carles contained barium salts, barium chloride having been used to remove the sulphuric acid. In some cases excess of the barium salt was found in the wine, and in others barium sulphate was held in suspension.

Closely following the abstract of this paper, in the "Journal of the Chemical Society, is another from the French "Journal of Pharmaceutical Chemistry," vol. v, pp. 581–583, to which I now refer, by-the-way, for the instruction of claret-drinkers, who may not be aware of the fact that the phylloxera destroyed all the claret grapes in certain districts of France, without stopping the manufacture or diminishing the export of claret itself! In this paper, by J. Lefort, we are told, as a matter of course, that "owing to the ravages of the phylloxera among the vines, substitutes for grape-juice are being introduced for the manufacture of wines; of these, the author specially condemns the use of beet-root sugar, since, during its fermentation, besides ethyl, alcohol, and aldehyde, it yields propyl, butyl, and amyl alcohols, which have been shown by Dujardin and Audigé to act as poisons in very small quantities." In connection with this subject I may add that the French Government carefully protects its own citizens by rigid inspection and analysis of the wines offered for sale to French wine-drinkers; but does not feel bound to expend its funds and energies in hampering commerce by severe examination of the wines that are exported to "John Bull et son Île," especially as John Bull is known to have a robust constitution. Thus, vast quantities of brilliantly-colored liquid, flavored with orris-root, which would not be allowed to pass the barriers of Paris, but must go somewhere, is drunk in England at a cost of four times as much as the Frenchman pays for genuine grape-wine. The colored concoction being brighter, and skillfully cooked, and duly labeled to imitate the products of real or imaginary celebrated vineyards, is preferred by the English *gourmet* to anything that can be made from simple grape-juice.

I should add that a character somewhat similar to that of natural dryness is obtained by mixing with the grape-juice wine a secondary product, obtained by adding water to the *marc*—i. e., the residue of skins, etc., that remains after pressing out the must or juice; a minimum of sugar is dissolved in the water, and this liquor is fermented. The skins and seeds contain much tannic acid or astringent matter, and this roughness imposes upon many wine-drinkers, provided the price charged for the wine thus cheapened be sufficiently high. After this, according to Gardner (Churchill's "Technological Handbook," "The Brewer, Distiller, and Wine Manufacturer"), "the same marc is treated in a similar manner with a fresh quantity of sugar solution, and sometimes undergoes as many as three or four separate macerations, each

successive infusion occupying a rather longer time. It will be easily understood that wine thus prepared costs less than very small beer, though its retail selling price may be regulated by the "*étiquette*" or label (from which I suppose our word ticket is derived) that is finally pasted on the bottles.

The special bouquets and curious flavors demanded by connoisseurs can be more easily added to mixtures largely composed of these second and third runnings than to simple grape-juice having its own grape-flavor, just as the juniper-flavor is more easily added to "silent spirit" than to whisky or cognac. We may thus obtain a clew to the mysterious fact that the market is well supplied with wines bearing the names of celebrated vineyards, of which the whole produce is bought by special contract by certain Continental potentates. Many of these château vineyards are so small that they can not actually produce one tenth of the wine that is *commercially* derived from them.

XLVII.—THE COLORING OF WINE.

Some years ago, while resident in Birmingham, an enterprising manufacturing druggist consulted me on a practical difficulty which he was unable to solve. He had succeeded in producing a very fine claret (Château Digbeth, let us call it) by duly fortifying with silent spirit a solution of cream of tartar, and flavoring this with a small quantity of orris-root. Tasted in the dark, it was all that could be desired for introducing a new industry to Birmingham; but the wine was white, and every coloring material that he had tried, producing the required tint, marred the flavor and bouquet of the pure Château Digbeth. He might have used one of the magenta dyes, but as these were prepared by boiling aniline over dry arsenic acid, and my Birmingham friend was burdened with a conscience, he refrained from thus applying one of the recent triumphs of chemical science.

This was previous to the invasion of France by the phylloxera. During the early period of that visitation, French enterprise being more powerfully stimulated and less scrupulous than that of Birmingham, made use of the aniline dyes for coloring spurious claret to such an extent that the French Government interfered, and a special test paper, named Œnokrine, was invented by MM. Lainville and Roy, and sold in Paris, for the purpose of detecting falsely-colored wines. The mode of using the Œnokrine was as follows: "A slip of the paper is steeped in pure wine for about five seconds, briskly shaken, in order to remove excess of liquid, and then placed on a sheet of white paper, to serve as a standard. A second slip of the test-paper is then steeped in the suspected wine in the same manner, and laid beside the former. It is asserted that $\frac{1}{100,000}$ of magenta is sufficient to give the paper a violet shade, while a larger quantity produces a carmine red." With genuine red wine the color produced is a grayish blue, which becomes lead-colored on drying. I copy the above from the "Quarterly Jour-

nal of Science" of April, 1877. The editor adds that the inventors of this paper have discovered a method of removing the magenta from wines without injuring their quality, "a fact of some importance, if it be true that several hundred thousand hectolitres of wine sophisticated with magenta are in the hands of the wine-merchants" (a hectolitre is equal to twenty-two gallons).

Another simple test, that was recommended at the time, was to immerse a small wisp of raw silk in the suspected wine, keeping it there at a boiling heat for a few minutes. Aniline colors dye the silk permanently; the natural color of the grape is easily washed out. I find, on referring to the "Chemical News," the "Journal of the Chemical Society," the "Comptes Rendus," and other scientific periodicals of the period of the phylloxera-plague, such a multitude of methods for testing false-coloring materials that I give up in despair my original intention of describing them in this paper. It would demand far more space than the subject deserves. I will, however, just name a few of the more harmless coloring adulterants that are stated to have been used, and for which special tests have been devised by French and German chemists.

Beet-root, peach-wood, elderberries, mulberries, logwood, privet-berries, litmus, ammoniacal cochineal, Fernambucca-wood, phytolacca, burned sugar, extract of rhatany, bilberries; "jerupiga" or "geropiga," a "compound of elder-juice, brown sugar, grape-juice, and crude Portuguese brandy" (for choice tawny port); "tincture of saffron, turmeric, or safflower" (for golden sherry); red poppies, mallow flowers, etc.

Those of my readers who have done anything in practical chemistry are well acquainted with blue and red litmus, and the general fact that such vegetable colors change from blue to red when exposed to an acid, and return to blue when the acid is overcome by an alkali. The coloring-matter of the grape is one of these. Mulder and Maumené have given it the name of *œnocyan* or *wine-blue*, as its color, when neutral, is blue; the red color of genuine wines is due to the presence of tartaric and acetic acid acting upon the wine-blue. There are a few purple wines, their color being due to unusual absence of acid. The original vintage, which gave celebrity to port wine, is an example of this.

The bouquet of wine is usually described as due to the presence of ether, *œnanthic* ether, which is naturally formed during the fermentation of grape-juice, and is itself a variable mixture of other ethers, such as caprilic, caproic, etc. The oil of the seed of the grape contributes to the bouquet. The fancy values of fancy wines are largely due, or, more properly speaking, *were* largely due, to peculiarities of bouquet. These peculiar wines became costly because their supply was limited, only a certain vineyard, in some cases of very small area, producing the whole crop of the fancy article. The high price once

established, and the demand far exceeding the possibilities of supply from the original source, other and resembling wines are sold under the name of the celebrated locality, with the bouquet or *a* bouquet artificially introduced. It has thus come about, in the ordinary course of business, that the dearest wines of the choicest brands are those which are the most likely to be sophisticated. The flavoring of wine, the imparting of delicate bouquet, is a high art, and is costly. It is only upon high-priced wines that such costly operations can be practiced. Simple ordinary grape-juice—as I have already stated—is so cheap when and where its quality is the highest, i. e., in good seasons and suitable climates, that adulteration with anything but water renders the adulterated product more costly than the genuine. When there is a good vintage it does not pay even to add sugar and water to the marc or residue, and press this a second time. It is more profitable to use it for making inferior brandy, or wine-oil, *huile de marc*, or even for fodder or manure.

This, however, only applies where the demand is for simple genuine wine, a demand almost unknown in England, where connoisseurs abound who pass their glasses horizontally under their noses, hold them up to the light to look for beeswings and absurd transparency, knowingly examine the brand on the cork, and otherwise offer themselves as willing dupes, to be pecuniarily immolated on the great high altar of the holy shrine of costly humbug.

Some years ago I was at Frankfort, on my way to the Tyrol and Venice, and there saw, at a few paces before me, an unquestionable Englishman, with an ill-slung knapsack. I spoke to him, earned his gratitude at once by showing him how to dispense with that knapsack abomination, the breast-strap. We chummed, and put up at a genuine German hostelry of my selection, the Gasthaus zum Schwanen. Here we supped with a multitude of natives, to the great amusement of my new friend, who had hitherto halted at hotels devised for Englishmen. The handmaiden served us with wine in tumblers, and we both pronounced it excellent. My new friend was enthusiastic; the bouquet was superior to anything he had ever met with before, and if it could only be fined—it was not by any means bright—it would be invaluable. He then took me into his confidence. He was in the wine-trade, assisting in his father's business; the "governor" had told him to look out in the course of his travels, as there were obscure vineyards here and there, producing very choice wines, that might be contracted for at very low prices. This was one of them; here was good business. If I would help him to learn all about it, presentation cases of wine should be poured upon me forever after.

I accordingly asked the handmaiden, "Was für Wein?" etc. Her answer was, "Apfel Wein." She was frightened at my burst of laughter, and the young wine-merchant also imagined that he had made acquaintance with a lunatic, until I translated the answer, and

told him that we had been drinking cider. We called for more, and recognized the "curious" bouquet at once.

The manufacture of bouquets has made great progress of late, and they are much cheaper than formerly. Their chief source is coal-tar, the refuse from gas-works. That most easily produced is the essence of bitter-almonds, which supplies a "nutty" flavor and bouquet. Anybody may make it by simply adding benzole (the most volatile portion of the coal-tar), in small portions at a time, to warm, fuming nitric acid. On cooling and diluting the mixture, a yellow oil, which solidifies at a little above the freezing-point of water, is formed. It may be purified by washing first with water, and then with a weak solution of carbonate of soda to remove the excess of acid. It is now largely used in flavoring as essence of bitter-almonds. Its old perfumery name was essence of mirbane.

By more elaborate operations on the coal-tar product, a number of other essences and bouquets of curiously imitative character are produced; one of the most familiar of these is the essence of jargonelle pears, which flavors the "pear-drops" of the confectioner so cunningly; another is raspberry flavor, by the aid of which a mixture of fig-seeds and apple-pulp, duly colored, may be converted into a raspberry jam that would deceive our prime minister. I do not say that it now is so used, though I believe it has been, for the simple reason that wholesale jam-makers now grow their own fruit so cheaply that the genuine article costs no more than the sham. Raspberries can be grown and gathered at a cost of about twopence per pound.

With wine at sixty shillings to one hundred shillings per dozen the case is different. This price leaves an ample margin for the conversion of "Italian reds," catalans, and other sound, ordinary wines into any fancy brands that may happen to be in fashion. Such being the case, the mere fact that certain emperors or potentates have bought up the whole produce of the château that is named on the labels does not interfere with the market supply, which is strictly regulated by the demand.

Visiting a friend in the trade, he offered me a glass of the wine that he drank himself when at home, and supplied to his own family. He asked my opinion of it. I told him that I thought it was genuine grape-juice, resembling that which I had been accustomed to drink at country inns in the Coté d'Or (Burgundy) and in Italy. He told me that he imported it directly from a district near to that I first named, and could supply it at twelve shillings per dozen, with a fair profit. Afterward, when calling at his place of business in the West End, he told me that one of his best customers had just been tasting the various dinner-wines then remaining on the table, some of them expensive, and that he had chosen the same as I had; but what was my friend to do? Had he quoted twelve shillings per dozen, he would have lost one of his best customers, and sacrificed his reputation as a high-class

wine-merchant; therefore he quoted fifty-four shillings, and both buyer and seller were perfectly satisfied: the wine-merchant made a large profit, and the customer obtained what he demanded—a good wine at a "respectable price." He could not insult his friends by putting cheap twelve-shilling trash on *his* table!

Here arises an ethical question. Was the wine-merchant justified in making this charge under the circumstances; or, otherwise stated, who was to blame for the crookedness of the transaction? I say the customer; my verdict is, "Sarve him right!"

In reference to wines, and still more to cigars, and some other useless luxuries, the typical Englishman is a victim to a prevalent commercial superstition. He blindly assumes that price must necessarily represent quality, and therefore shuts his eyes and opens his mouth to swallow anything with complete satisfaction, provided that he pays a good price for it at a respectable establishment, i. e., one where only high-priced articles are sold.

If any reader thinks I speak too strongly, let him ascertain the market price per pound of the best Havana tobacco-leaves where they are grown, also the cost of twisting them into cigar-shape (a skillful workman can make a thousand in a day), then add to the sum of these the cost of packing, carriage, and duty. He will be rather astonished at the result of this arithmetical problem.

If these things were necessaries of life, or contributed in any degree or manner to human welfare, I should protest indignantly; but seeing what they are, and what they do, I rather rejoice at the limitation of consumption effected by their fancy prices.

A NATURALIST'S EXCURSION IN DOMINICA.

By Dr. FR. JOHOW.

THE British Island of Dominica, although it forms only an insignificant colony, takes a rank among the first of the West Indies, when considered in regard to the richness of its scenery. Built up of lofty volcanic masses, which interpose almost insurmountable rocky barriers to the entrance of civilization into the interior, it still conceals among its hills and ravines a life of animals and plants rejoicing in the wildest freedom, and which is developed under the moist, tropical climate into extreme luxuriance. If one desires to make himself acquainted in the shortest possible time with the life of the island, he can do no better than make an excursion to the "Boiling Lake," that wonderful hot water-crater in the interior, which is one of the most curious geological phenomena of the earth. The road of about fifteen miles, but which it takes two or three days to traverse, so rugged is it,

from the west coast, passes through cultivated and half-tilled lands into a romantic river-valley, and then through the primitive wilderness over hills and mountain-torrents, into an upland valley about three thousand feet above the sea, in the bottom of which lies the boiling lake, surrounded by a grim waste of volcanic rocks.

The starting-place for our excursion is the little town of Roseau, the chief place of the island, and the only one where the traveler will find a boarding-house, situated on the west coast, picturesquely set down at the mouth of a romantic valley, among sugar-cane fields and palm-gardens, and framed by forest-covered mountains. Before starting on our excursion we will make a short study of the shore, a flat beach of sand and gravel, sunny, hot, and dry, but which supports a characteristic vegetation. We are struck, in looking at this beach-flora, with the predominance of the creeping plants, by which the most diversified botanical families are represented. Their habit of growth, with the multitude of rooting points it permits, gives them great advantages in keeping their hold on the shifting sands, and access to numerous points at which they may tap the soil for its scanty supplies of moisture. The succulent nature of the organs is another peculiarity of these plants that will strike the Northern observer. Most of them, whether they be creepers or upright, are either provided with fleshy leaves, or consist of amorphous thick stems without expanded foliage. This property, which must be regarded as a provision to diminish transpiration, is, as every one knows, not uncommon in the vegetation of dry places. In the tropics it marks not only the shore plants and the vegetation of the arid plains, but also the epiphytes, which live upon the dry bark of the trees. European species are represented in this growth by the portulaccas. Among the plants is one, *Bryophyllum calycinum*, which has long been known to gardeners and botanists by the faculty which its leaves possess, when broken off and laid upon the ground, of developing buds on their edges, which finally become independent plants. This, instead of being a merely adventitious peculiarity, marked only under special circumstances, as has been supposed, is really the normal provision of Nature for the propagation of the plant. This species forms in the course of its growth two kinds of leaves; the entire leaves of the young plant, which are shaped like those of the common live-forever, and, at a later stage of growth, cleft leaves. The two kinds of leaves are not equally competent to form buds, but the property is a peculiarity of the cleft ones. When we gently draw the hand over a well-grown plant of *Bryophyllum*, we will find the feathered leaves falling like ripe fruits to the ground, while the entire leaves remain fixed upon the plant and will not be disturbed by any shaking. Examining the fallen offsets a few days afterward, we will find their upper surfaces crowned with a circle of sprouts around the edges, while to the lower side is attached a tuft of young rootlets. The plantlets live at first on the nourishing matter of the

young leaf, but soon become wholly separated and acquire an independent existence, to become in turn parents of a new brood. Some other plants multiply by offsets from the leaves, but the exhibition of a differentiated propagation-leaf is peculiar to this one. Among the trees that attract our attention is the shore-grape (*Coccoloba uvifera*), with its curious knotted and bushy growth, and its thick, hard leaves, which is found nowhere but in the Antilles. It offers an odd combination of the creeping and upright growths: in the isolated specimens, the lower limbs bend down and run along the pebbly beach, but without taking root; while the upper limbs spread themselves out in the air, at this time hung with whitish flower-spikes, which are later to develop into the dark-blue "grapes of the shore." On the beach a few miles north of Roseau are some plants of the manchineel-tree (*Hippomane mancinella*), now becoming quite rare, which is fabled to be deadly to all who sleep under it. The thing that is true about this myth is, that the sap contains an acrid poison that causes painful sores on the skin. The botanist Jacquin, who visited the Antilles in the middle of the last century, says that no animal would touch the fruit of the manchineel, though the ground under the trees was covered with it and inhabited by innumerable crabs. Jacquin denies that there is any danger in sleeping under the trees, because he and his companions rested under one of them for three hours without feeling any inconvenience from it. In his time, manchineel-wood was used for fine cabinet-work, and was obtained without risk from poisoning by building a fire around the tree, by which the greater part of the sap was boiled out, and then cutting it down very carefully with the face veiled. The *Capparis cynophallophora* attracts notice by its curiously shaped flowers, conspicuous through their numerous long, cream-colored filaments which, drooping when they first come from the buds, gradually erect themselves into an umbel of elastic threads. They are visited by hosts of insects, which, striking against the stamens in their efforts to reach the nectaries, set them into rapid motion and become dusted with the pollen, and are thus constituted bearers of it to other flowers; for the *Capparis* is proteranderous, and only the pistils of flowers that have already cast their pollen are capable of being fertilized. Conspicuous objects are the papilionaceous flowers of the *Erythrina corallodendron*, which, the tree being leafless at this season, reveal themselves to a vessel approaching the coast in bunches of gorgeous scarlet.

If we continue our excursion till sunset, we are overtaken in returning to the town by the sudden coming on of darkness, for the twilight is very short in this low latitude. But, hardly has the departed sun ceased to gild the crowns of the cocoa-palms, than the moon sheds her soft light through the delicately feathered foliage of the tamarind-trees under which we are walking. With every succeeding minute the crowns of these trees grow more transparent and open; for the leaves

are putting themselves to sleep, and folding their filaments up against their petioles.

Early in the morning we start for our first night-station, the negro village of Laudat, seven miles from Roseau, in the mountains. We might go on horseback, but prefer a way that will give opportunity for close biological observations; so, having a negro to carry our baggage and botanical books, we start out, armed with umbrella, gun, and opera-glass, with which to scan inaccessible specimens in the tree-tops, on foot. As we pass through the cultivated lands, we admire the areca and cocoa palms, but are disappointed with the banana-trees, whose leaves have been torn to shreds by wind and rain, and find the bread-trees at this season presenting but a sorry spectacle. The dark masses of the mango-trees make a better impression, and it is impossible to repress admiration of the calabash-trees (*Crescentia cujete*), with great pumpkin-fruits hanging from the tips of their slender limbs, and which are devoted to such varied uses: the fruit-pulp to be made into a vegetable viand; the pumpkin-shell into vessels and dishes of every sort; and the outer bark by the West Indian orchid-growers as the ground on which to cultivate their fancifully shaped floral treasures. As we examine the plants by the roadside, many of them stragglers from the sea-shore or from foreign parts, we are struck with the variety of the provisions by which they adapt themselves to resist the heat and aridity of the dry season. We have already mentioned the succulent stems and the condensed surface of the beach plants, and the leafless condition of the coral-tree (*Erythrina*), which other *Leguminosæ* also assume during the heats. These and other peculiarities for the same end are exhibited not in the same degree for all of the species, but with numerous individual variations according to the special circumstances of each particular plant, and in such a way as to demonstrate a capacity for individual adaptation. Here are, close together, two specimens of the *Bryophyllum calycinum*, one standing in the open sunlight, and the other under the shadow of an acacia-tree. The former plant has relatively small, thick leaves, the structure of which is seen under the microscope to be close and made up of palisade-like cells; while the other one displays much thinner and more loosely built leaves, exposing many times as much surface to the light as its companion did. Another method of adaptation is shown in the posing of the surface of the leaves parallel to the sun's rays instead of perpendicularly to them. This position in profile sometimes occurs as a peculiarity of the species; is sometimes brought about by the version or folding of the leaf-blades; and is sometimes dependent upon periodical movements of the leaves, which seem to be provided with particular organs for the purpose, according to the intensity of the light. The profile position appears to be fixed in the shore-grapes, which we observed on the beach, in the sapoteas, and in some other species. The faculty of folding the leaves appears rather to be one of individual

adaptation. The leaves of the *Bryophyllum* appear folded in the sun, spread out flat in the shade; and the same phenomenon was observed in a modified form in the very abundant *Psidium Guava* and some other species. Other plants form close and hard cuticles which restrict evaporation, and some others appear to be furnished with special water-vessels in their hypodermic layers. To this class seem to belong the thick-leaved calabash-trees and shore-grapes, and the creeping *Commelyaceæ*.

From admiring a number of highly colored flowers, our attention was drawn to the modest sensitive-plant (*Mimosa pudica*), which was here growing in masses as a common weed alongside of the cultivated fields. A goat was feeding along the hedge-side, and had stretched out his tongue toward the delicate mimosa-leaves, but had not reached them, when he suddenly drew his head back in astonishment at the strange sight of an array of sharp thorns, forbidding closer approach, where he had only an instant before anticipated the taste of a mouthful of delicious foliage. The mimosa thus protects itself against the unwelcome feeder upon it in the same manner as the hedgehog escapes his enemies by rolling himself up into a prickly ball. Now was explained to us the observation we had made before in the country, of islands of mimosa-plants rising untouched from the pastures in which all the other plants around them had been closely eaten away. The same property of withdrawing itself from unfriendly contact operates to protect the mimosa against injury from wind and rain.

As we go up the mountain-walled valley of the Roseau, in the intervals of which cultivation still presses hard upon the primitive vegetation, we admire the variety and brilliancy of the extra-floral display by which some of the species are made conspicuous, and which is one of the marked features of the West Indian flora. Here is a begonia, with rose-red peduncles; there are some bromelias, with brightly colored bracts attached to their flower-stocks. The *Heliconia*, or wild-banana, is marked from afar off not more by its enormous leaves than by the brilliant purple spathe that surrounds its unobtrusive inflorescence; and the *Euphorbia heterophylla* is equally distinguishable by the patches of crimson on the whorl of leaves nearest to its flowers; while many other plants have their real leaves variegated with stripes or spots of color. Of most graceful and noble bearing are a group of tree-ferns, the unapproachable delicacy of whose leaf-carving, the remarkable harmonizing of the green of their foliage with the dark brown of their stems, and the perfect symmetry and pose of their crowns, are worthy of and receive the highest admiration. As we continue the ascent, the wood becomes largely composed of the *Bursera gummifera*, a tree of the terebinth family, the magnificent stems of which are supported by wide-spreading pillar-roots and varnished with the white balsam that has exuded from their bark. Moss-like plants nestle under the shelter of the root-pillars, lianas climb around the

trunks, and multitudes of epiphytes flourish in their airy crowns, among which we are surprised to see the *Clusias*, themselves trees, enthroned high upon the topmost limbs. From the height of more than a hundred feet these parasites, called in the country "Scotch attorneys," and "cursed fig-trees," send their rope-like, tufted air-roots clear to the ground, to draw up water and food to their lofty abode, while they establish their mechanical security on the stem of the mother-tree by a close network of holding-roots. Sometimes the *Bursera* dies in the embrace of the strangler, and its trunk molders away without crumbling up, within its tight envelope, and finally falls, if it is not held up by the vines, bringing its destroyer down with it.

At Laudat, where we are to spend the night, two thousand feet above the sea, we find a better opportunity than we have ever before enjoyed to become acquainted with the structure and habits of the epiphytic phanerogams. At all other places on the island these plants live in the tree-tops, and we have to content ourselves with looking at them through the glass, or to rely for more careful examination upon such specimens as we can bring down with the gun. Here, where the forest has been cleared away for several acres, these plants have come down with the trees, and, finding enough light near the ground, live upon the bushes. They have been quite fully described by A. W. F. Schimper, in the "Botanisches Centralblatt," and we check our own observations by his account. Most of the epiphytes of Landat belong to the families of the orchids, aroids, bromelias, and ferns, while many other families are represented by individual forms.

The peculiar conditions under which these plants live require peculiar adaptations. One of their most general characteristics, and frequently a very prominent one, is the succulent or leathery constituency of their leaves, which, operating to impede transpiration, well adapts them to the dry conditions of their dwelling-place. Some of them are protected by a clothing of hairs. Many epiphytes are characterized by superficial extensions of their organs at relatively small heights above their substratum ; quite usual are the arrangement in rosettes of the leaves at the base of the stem, thickenings of the stem into knots, and a creeping or climbing habit—all peculiarities denoting adaptation to the absorption of water and food, and to the gaining of a secure footing on the substratum. In the way of special adaptations, we may, with Schimper, distinguish among the epiphytes four groups, according to the manner in which they take up their food.

Those of one group simply derive their nourishment from the bark to which they are attached, and are in this respect analogous to the ground-plants. Those of the second group send down roots to the ground, besides those by which they adhere to the tree, and thus put themselves as to nourishment in almost precisely the condition of ground-plants. Of these are the *Clusia*, which we have described, and two plants which were conspicuous at Laudat, by their handsome flow-

ers and the luster of their leaves. In some epiphytal orchids, aroids, and ferns, the roots weave themselves on their bark support into something like birds' nests, in which are gradually accumulated dead leaves and other organic *detritus*, to form a humus. The fourth class, to which the bromelias belong, is distinguished from all the others by the fact that water and food are taken up by the leaves, while the roots are either not developed, or are reduced to mere organs of attachment. The *Tillandsia usneoides* ("Spanish moss"), which, having no roots, hangs from the limbs, is clothed with a silver-gray hair, having shield-like processes which represent water-absorbing organs. Other epiphytic bromelias have similar absorptive vessels, and special provisions in the dish-like arrangement of the leaf-rosettes for storing rain-water and dew and more solid food for a considerable time. One may be convinced in a very instructive manner of the presence of water in these leaf-basins, by bending down a limb covered with epiphytes, when, unless he proceeds very carefully, he will receive a quart or more of water on his head. We learn from these considerations that these epiphytes are not real parasites, but only tenant forms, which, fixing their homes on other plants, derive their food support from the atmosphere and from dead matter. There are, however, besides these, real parasites at Laudat, which prey upon the living wood of the trees.

Among the forms of animal life at Laudat are three humming-birds, one of which is so tame that the children catch it in their hands, and another is hardly two inches long; and, in sharp contrast with them, the largest of all insects. This is a beetle, which entomologists have named, in recognition of its gigantic size and great strength, *Dynastes Hercules*. The male is armed, like our stag-beetles, with two immense tusk-like processes on the head, the physiological significance of which is unknown. The female is unarmed, and of much more slender constitution.

So absorbed were we in the contemplation of the new forms of life around us that we would have been unmindful that the afternoon was passing away were it not that a bird called out to inform us that the sun would set in half an hour, and ten minutes later it would be dark. The sunset-bird, as the American Ober, who discovered it in this island, has named it in his "Camps in the Caribees," utters its peculiar cry only twice during the day—half an hour before sunrise, and as long before sunset—and keeps complete silence for the rest of the day. For a very brief interval after sunset the air is perfectly clear and transparent, and the light-effects are most picturesque; then, as if some signal had been given, begins the concert of the tree-frogs and locusts, and finally darkness settles over the landscape, to be broken up shortly by the rising of the moon, whose light gives a new series of picturesque effects.

Early in the morning we are awakened for a bath at the junction

of two brooks, one bringing warm water from the mountains and the other cold water from springs, where we may take our choice between the temperatures, or of a mixture of the two, or between a douche and a plunge-bath, and for our final start to the boiling lake. There are two bodies of standing water on the island: one is called the fresh-water lake, and is cold; while, though lying at a considerable height above the sea, and probably occupying an extinct crater, it is less remarkable for its geological features than for the beauty of its surroundings. The other, the "Boiling Lake," is the object of our excursion. Soon we entered upon a dark wood of painful grandeur. The trees were so large and tall that we were not able with the naked eye to distinguish the forms of the leaves, the flowers, or the fruit upon a single one of them. Even our guns could not reach the atmospheric vegetation, and we had to content ourselves with the examination of casual fallen specimens, or with pulling at the ropy air-roots of the clusias, when the pouring of water into our faces would inform us that there were tillandsias and brocchinias above. Of animal life, we observed a curious rodent occasionally dashing quickly across the way, but no large mammalia, and two large brightly colored parrots peculiar to the island, of which we did not succeed in getting any specimens. It is a remarkable fact that most of the birds of Dominica are found nowhere else. The ornithologist Ober, who visited Dominica in 1880–'81 and studied its birds, was surprised to remark that a very considerable proportion of them were of perfectly new species. Another species that must not be forgotten is one of large land-crabs which run over the ground, and of which Ober records the habit of going every year in the same month to lay their eggs in the salt-water, where they may be met by thousands and thousands. In a short time we reach a mountain-river of clearest water, which is called the Breakfast River, because excursionists to the boiling lake, reaching it at about ten o'clock in the morning, are accustomed to stop and rest awhile and take their breakfast.

On the other side of this stream we have to climb a steep, bush-clad rock-wall, till in an hour we reach the top of the mountain and look on a panorama of astonishing magnificence. Behind us in the west lies the forest we have traversed, and the narrow green valley of the Breakfast River. Before us in the east stretches a bare, ravine-cut waste, strewed with volcanic stones and yellow sulphur-beds, and seething with hot springs, streams, fumeroles, and solfataras, covered with the remains of destroyed woods, and crowned with a pillar of vapor reaching to the clouds. Beyond a turn of the valley at our feet sounded a dull rumbling, which with the vapor indicated to us the direction in which the boiling lake lay. We scramble over the steep cliff into the valley through a wood of trees burned to a cinder, but yet standing. This desolation was occasioned by an eruption of the lake, which took place in 1880, by which immense masses of glow-

ing ashes and hot mud were thrown over the wooded valley-wall. Between the grim trunks, which are so brittle that they crumble at the slightest push, and which offer not the least of the obstacles to our descent, the ground is covered with ejected matters and pebbles, with here and there some plant growing in the interstices. In the bottom of the valley flows a warm, steaming stream, which is fed by little brooks rushing down on every side, foaming between the blocks of stone. Most of these affluents run with colored water—one blue, another yellow, a third milk-white, a fourth maroon, etc., according to the mineral constituents which it holds in suspension or solution. At many places aqueous and sulphurous vapors issue from the ground as if from the valves of a steam-engine, and here and there is a steaming basin from which escape tumultuous blasts of gas. The bed of the stream is beset with great bowlders, over which we have to find our way with much difficulty and some danger by springing from one to another. Finally we reach the edge of the boiling lake in a state of extreme exhaustion.

A glance into the infernal caldron that lies before us informs us that we are standing here at the mouth of a still active volcano. The basin of the lake lies in the midst of a deep, steeply descending cup, the crater, to which two streams come from the north. One of the streams brings cold chalybeate water, and runs by the basin to unite with its warm effluent; the other, bringing warm water, empties into the boiling lake. On the south side of the crater gaps an opening in the wall which constitutes the outlet of the lake. It is of quite recent origin, for it dates only from the great catastrophe of 1880, in which the valley-forest was destroyed. Previous to this time the area of the lake was about three times as great as it is now, when its diameter is only about forty-five paces. In the center of the basin is a geyser issuing from a mound of black mud, which, when we observed it, spouted to a height of some fifteen or twenty feet. Other observers have given it a height of from sixty to a hundred feet. In the interior of the mud-heap of the geyser we remarked, whenever the wind blew the steam away, a kind of tufaceous structure, of which we were not able to learn anything more exactly. Great masses of sulphurous gas escape over the whole surface of the basin from the black, muddy fluid, and keep up a loud roaring and humming, which only heightens the dismal aspect of the whole place.

This was the end of our excursion into the interior of Dominica. —*Translated for the Popular Science Monthly from Kosmos.*

ENGLISH EXPERIENCE WITH CANCER.

By H. PERCY DUNN, F. R. C. S.

THERE is reason for the frequent inquiry which meets the ears of medical men in the present day, Is it not true that cancer is increasing? For, however much we may attempt to throw into the shade our convictions upon this matter, the records of the Registrar-General remain to show, in all the obtrusiveness of an unvarnished statement, the annual increasing mortality from this terrible disease. A reference to the forty-third annual report of the Registrar-General discloses a somewhat alarming state of things, in connection with which it must be conceded that reflection affords but little assistance in the attempt to solve the cause. According to the report, 80,049 deaths from cancer occurred during the ten years from 1860–'69 inclusive, and the annual average increase was 248. During the years 1870–'79 the total number of deaths from cancer was 111,301, and the annual average increase was 320. As far, therefore, as numbers are capable of showing, we have here conclusive evidence of the increment in the mortality from cancer. It is observable also that the rate of increase is much higher in the latter than in the first ten years. It is, moreover, the case that the annual rate of increase is higher in the years 1860–'69 than in the preceding decennium—namely, in the years 1850–'59. In short, in the years 1850–'59 the increment was about 2,000; in 1860–'69, 2,400; in 1870–'79, 3,200. We have then confessedly to face the fact that cancer is increasing in our midst at a rate which bids fair to become more and more serious with the advance of time. In an article entitled "An Inquiry into the Causes of the Increase of Cancer," published in the "British Medical Journal" a year ago, I drew attention to the observations which had been made upon the subject by the late Charles Moore, whose investigations into the pathology of cancer had brought under his notice the incontrovertible evidence of the increase of the disease. In the year 1865 he published a small book called the "Antecedents of Cancer," the contents of which chiefly consist in an attempt to explain in what manner the augmentation of cancer is influenced by the circumstances of life prevailing in this country. For instance, he held that the introduction of corn laws, the discoveries of gold and sanitary improvements, whereby the well-being of the nation was conspicuously established, affected cancer indirectly by bringing into prominence the predisposing causes of its occurrence; and good living, it is thought, which follows as a corollary of commercial prosperity, is intimately associated with the manifestation of cancer. Again, inasmuch as cancer is characteristic of the healthy, it may be expected to abound amid the conditions of health. The greater prevalence of the disease among the rich than among the poor can probably be explained in this manner. According to a French observer, the proportion of cancer in the wealthy classes is about 106

in 1,000, in the poor classes it is 72 in 1,000; or at a rate in the former case of ten per cent, and in the latter of seven per cent. Now, curious as it may seem, cancer is met with in the lower animals; and it has been said to prevail more frequently among those which are flesh-eaters than those which are herb-eaters. It has been stated by the late Dr. Crisp, who had good opportunities of judging, that cancer is by no means an uncommon disease among the domesticated animals, while in wild animals and uncivilized man it is rare. In 230 also of the quadrumana which he had examined there were no traces of cancer. Thus the inference to be drawn from these statements appears to be plain. It is almost conclusive that the habits of life, either in man or the lower animals, are concerned in the production, or at least in the predisposition, to cancer. The surroundings, it is conceivable, of an autochthonic existence do not include influences which favor the production of the disease; consequently, in uncivilized man the disease is rare. It is, however, different when man becomes civilized, for then the predisposing, if not exciting, causes come into play, and man has entered an area of life in which the disease has acquired not only a pronounced but an augmenting fatality. And the same is true of animals. Now, as far as we know at present, cancer has not a zymotic origin; in other words, it does not arise from any micro-organism or "germ." It is consequently neither infectious nor contagious. Cancer, in short, can neither be "caught" nor "given." It commences *de novo* in each individual whom it attacks. There is, moreover, no such thing as anything cancerous being transmitted from parent to child in the cases in which the disease occurs in one and the other. It is possible to inherit a predisposition to cancer—that is, if cancer appears in a family, the members may be said to possess a liability to the disease, but practically this statement does not convey with it much significance, because, until the disease becomes manifest, no person can be said to be cancerous, inasmuch as he does not inherit the disease, but simply the liability to it. We are confronted with the problem of how to limit the frequency of the disease, and the difficulty of this is apparent in view of the fact that we know almost nothing of its origin. Cancer, as I have said, is not contagious; it stands almost alone as a disease which increases with our prosperity, and, while our health laws are raising the standard of public health, the mortality from cancer stands forth as a blot upon the results, detracting in part at least from the measure of the success that has thus far been obtained. Observation has shown that cancer has a certain geographical distribution. It prevails extensively in some parts of the globe, and is scarcely known in others. For instance, it is met with most largely in the central parts of Europe, but in the extreme north of this continent the inhabitants enjoy an almost complete immunity from cancer. It is stated to be unknown in the Faroe Islands, while in Iceland in one year it proved mortal in only thirty-seven cases out of 50,000 inhabit-

ants, or in a proportion of 0·07 to 1,000. With reference to England in this connection, Englishmen may be regarded as unfortunate; for within the geographical area of these islands cancer asserts largely malignant and fatal influence. It afflicts mankind chiefly at an age at which, by universal consent, life is best enjoyed. Many and various have been the attempts devised to combat the inevitable fatality of its accession. A few years ago, a drug, Chian turpentine, was somewhat extensively employed, its introducer, Dr. Clay, claiming that under its influence cancerous tumors would gradually diminish in size, and ultimately dwindle away. But, unfortunately for humanity, various scientific trials, prosecuted with uncomplaining forbearance on the part of the sufferers, yielded in the end negative results, and Chian turpentine was again relegated to the obscurity from which it had emerged for a brief space of time. The gleam of light, however, which has shed some radiancy over the gloominess of cancer, comes from surgery. It may be said of the surgery of the present day that better results are obtained from the surgical treatment of cancer than was probably the case in any former age. Some operations are now being practiced which hitherto were not considered justifiable, owing to the want of success which followed their performance. Others have lately been introduced, the practicability of which has proved the wisdom of their conception. Sufferers from cancer who formerly would not have been relieved are, in the present day, benefiting from the application of the principles of scientific surgery. Years of life—some years at least—and the mitigation of much physical and mental suffering, fall to the lot of surgeons to confer. Even the stomach, which in the male after a certain age commonly becomes the seat of cancer, has been dealt with, and a portion of it removed which was diseased, the result being favorable in so far as suffering was relieved and life prolonged. It must be, however, remembered that the successful treatment of cancer depends as much upon its early recognition as upon the means adopted for its relief. There should be no hesitation in ascertaining the nature of a tumor or swelling which is suspicious or uncertain. The improvements in the methods of diagnosis enable surgeons to recognize cancer in its earliest stages; and as soon as the presence of the disease becomes unequivocally demonstrated the probability of a successful result is largely enhanced by its early removal. The reason for this is obvious. Cancer commences in each person presumably as a local disease. But it spreads and infects by means of the blood-vessels and lymphatics, first the nearest lymphatic glands and then the more distant organs of the body. When this has occurred, the disease is no longer a local one, it has become what is called constitutional. It is therefore manifest that the most favorable time at which to obtain the best results from surgical interference is when the disease persists simply as a local growth, and when the blood and tissues of the body have not received the impress of a cancerous taint.—*Pall Mall Budget.*

SUPERSTITIONS ABOUT THE DOLPHIN.

By Dr. BIEDERMANN,
OF THE GYMNASIUM OF HALLE.

NO animal of the sea or land figures more frequently in the fanciful creations of the Greeks and Romans than the dolphin, king of the Mediterranean Sea. It is represented in their myths as an attribute, symbol, companion, and servitor of the mighty gods, who were themselves not ashamed to borrow its form; in the epics as the friend and deliverer of the Grecian heroes, even of historical men, whom it carried on its back over the waters; in the stories as the playmate and fondling of handsome boys, whose death it could not survive. As in poetic art, so was it also adopted as a form of beauty down to the latest after-bloom of Roman plastic arts of design, equally in painting and as an ornament on the articles of daily life, on vases, coins, and cut stones, on the borders of Etruscan mirrors, etc. It is not strange, then, that these motives entered even the scientific work of antiquity, and the dolphin was elevated into an ethical type of the animal world. Ælian ascribed to it a parental love that did not fear death for the sake of its young. The mother would not forsake her young one when it was caught, but would share captivity and death with it; if one of two was taken, the mother would drive the other away from the danger, and then go back to perish with the caught one. Ælian tells of many such traits which seem to reveal a kind of human nature in the dolphin, and to connect it most intimately with man and his sea-life. Dolphins were said to accompany the ship of the hardy sailor over the solitary sea, to endeavor to entertain him with their sportive movements, and to be so confiding that, if they were called by the name of Simon, they would come up and help the fisherman in his work of driving the fish into his net. They forewarned him of the storm, also had a good feeling toward bathing boys, and exhibited thankfulness toward man. The spiritual qualities of the dolphin appeared not less deep to antiquity. If a dolphin was caught, he would greedily eat all the fish that were caught with him, then would break the net and escape; hence the wise fisherman, if he casually caught a dolphin, would draw a rush through his nose and let him go, marking him for another time. That such an animal, to which a lavish fancy ascribed so many noble qualities, should have enjoyed in reality a certain degree of honor and indulgence, follows as a matter of course, especially when it is remembered that the dolphin was of little value when caught, but when at large could often make himself very useful by driving up the smaller fishes toward the nets, as the whale does in the herring-fishery. The southern people, who were otherwise not particular as to the quality of their food, spared the dolphin, and it is still considered inviolable on the Sea of Marmora. With a few exceptions, dolphins were abhorred by

the cultivated classes. The Byzantines had so little regard for them that they caught them and salted them. It was not thought amiss to make them of use in medicine according to the presumed laws of sympathy and homœopathy. The fat of the dolphin, eaten with wine, would cure hydrocephalus; its teeth would ease the teething of children, if the proper bones were rubbed upon the gums or burned to ashes and taken; and they served as amulets to protect against sudden dangers. To dream of this wonderful animal signified good, while the dreaming of any other creature of the water betokened evil.

Such representations by the ancients were the more singular, because the dolphin in reality is so strikingly different from them. According to science, the dolphin is the boldest, most greedy, and fiercest robber of the sea, the terror of the smaller fish, especially of the flying-fish, which leaps into the air in fear of it. How was it possible, in the face of qualities so directly opposite, for the dolphin to be made the pet of poetic and figurative art among a people who were otherwise so keen in their perceptions? The question may be answered, generally, by considering the two fundamentally different points of view from which the ancients and the moderns regarded the animal world. The Greeks, and still more the people of the middle ages, were generally inclined to put the realistic and scientific side in the background, and to look at animals from the religious, moral, and sentimental point; the humoristic-satirical character of the romantic and Germanic animal-poetry of the middle ages is a departure in another direction. It would, however be a mistake, and would underrate the clear comprehension of reality possessed by the Greeks, to suppose that all these traits of dolphin-life were mere fancy-pictures. The dolphin was observed correctly on the whole, but the lively imaginative faculty of the sailors and fishermen, easily moved to exaggeration in contemplating the immensity of the sea, unconsciously underlaid the natural behavior of these animals with moral motives. With later peoples, those traits were exaggerated on the sentimental side. Large schools of dolphins followed the sailors in clear weather and amused and entertained them with their arrow-like movements, and with the gracefully waving lines which they left on the waters, while everything else avoided the ship. It was easy for them to imagine that all this was done for their sake, and in consequence of the dependence of the animal upon man. The fancy naturally arose that the dolphin by his movements warned men of approaching storms; and it became regarded as a power and a symbol of the sea and sacred to Neptune. As the lion was king of the animals of the land, so was the dolphin king of the animals of the sea; and as the former, according to the story, ate apes to renew his strength in his old age, so did the dolphin prolong his life to three hundred years by eating sea-apes. Thus a humanizing of Nature took place in this fancy of the Greeks, as in everything else they looked at. It was imagined that the dolphin could call with a whistle, and when

this was believed, it became a sure evidence to the Greeks that the animal must have once been a man, one of the wild, piratical, Tyrrhenians whom Dionysus in punishment changed into a dolphin. Out of this grew the idea of the moral attributes that were ascribed to the animal, its parental love, its humors, etc. Thus it became still more appropriately a symbol of the sea and a constant companion of Neptune, while its speed was compared with that of the horse, a creature of Neptune's. It was the dolphin that hunted up Amphitrite when she fled to the depths of the sea to avoid a marriage with Neptune, and guarded her till the god led her home as his spouse; and Neptune, in recognition of its skill and fidelity, made it his sacred animal, and set it as a constellation in the northwestern sky. Thus it came also that Ulysses, the ideal sailor, carried the symbol of the dolphin on his shield and wore it engraved on his signet-ring.

These mystic views of the animal were impressed on other people, and found expression in new tales and forms. Conrad, of Megenburg, the first German naturalist, introduced them to the Germans in the fourteenth century, to whom he described the dolphin as an animal without malice, living to be a hundred years old, loving music and friendly to men, and told the story of Arion and the boys with the dolphin. The Greek myths were also translated to the Christian saints' legends, and we have in the latter stories of wonderful deliverances of God-beloved persons, like those which had so often appeared in the Hellenic epics of a thousand years before; and the dolphin thus found its way into the ancient Christian symbolism, where it figured as an emblem of love, of marriage-fidelity, and of the Christian; for it was regarded as a fish, and the fish was used (after the text in Matthew iv, 19, "I will make you fishers of men") to designate souls gained by baptism or conversion. Therefore it is often found on baptismal basins, and on grave-stones in the catacombs to indicate that the person resting there was a Christian; and it occurs, with an anchor, on the lids of Christian coffins. This curious and peculiar symbolism is less wonderful when we reflect that ancient Christian art was wont, in its dread of anthropomorphism, to betake itself to zoömorphism, and that it represented Christ himself by a fish. In the Belgian legends, the largest fish of the country, the sturgeon, figures instead of the dolphin as the deliverer and leader, and carries St. Amalberga over the Thames when she wishes to go to a cloister. In the German legend, Notburga is assisted across the Neckar by a stag.

These considerations will help to explain much that is mysterious in myth, legend, and art, in reference to the dolphin. It is quite obvious also that ancient artists prized this animal the more because it belonged to the beautiful forms of nature. The graceful lines of its body, contrasted with the relatively monotonous outlines of the fishes, commended it to their regard, and were appreciated by artists on account of the animation which the animal's movements in the water imparted

to them. Nevertheless, a comparison of the picture of a real dolphin with an ideal dolphin will show that a bare naturalism could have made much less than art has made out of the animal. But the ancient artists treated the animal world with great freedom, and a large appreciation of its spirit; they only made the real form prominent and mingled the unreal with it, or threw it entirely away, and thus by skillful treatment made a picture agreeable to the eye. This freedom was more justifiable, because the Greeks never had a particular species of dolphin in view; but, as Cuvier has shown, confounded with it the smaller sharks, thus inventing the extreme diversity of forms in which dolphins are depicted. Add to this the unstable element of the water in which the dolphin was always seen sporting, and the impossibility of getting an accurate view of its form under the circumstances, and it is evident that an artistic fancy might readily and legitimately exaggerate the proper form into the most grotesque. It would, of course, be natural for art to represent the animal as always in motion, and its tail with its sickle-shaped fins in the air after the manner in which it always showed itself to the sailors who observed it.—*Die Natur.*

THE PARENTAL FORESIGHT OF INSECTS.

IN no manner is the mysterious influence of instinct over the insect world more remarkably manifested than by the care taken by parent insects for the future welfare of offspring which they are destined never to behold. As the human parent upon his death-bed makes the best provision he can for the sustenance and prosperity of his infant children, whom death has decreed that he may not in person watch over, so those insects which Nature has decreed shall be always the parents of orphan children, led by an unerring influence within, do their best to provide for the wants of the coming generation.

The butterfly, after flitting through her short life, seeks out a spot whereon to deposit her numerous eggs, not—as one might expect of a creature devoid of mind—upon any chance plant, or even upon the plant or flower from which she herself has been wont to draw her sustenance, but upon the particular plant which forms the invariable food of the larvæ of her species. The various kinds of clothes-moths penetrate into our cupboards, drawers, and everywhere where furs, woolen garments, etc., are stored, that they may there lay their eggs, to hatch into the burrowing grubs which are the terror of our housekeepers. The ichneumon tribe, one of Nature's greatest counterpoises to keep down the too rapid increase of the insect world, lay their eggs in the larvæ of other insects, which eggs when hatched develop into a devouring brood, which ungratefully turn upon and devour the helpless creature that sheltered them as a nest. The female ichneumon

having discovered a caterpillar or grub which her instinct informs her has not been previously attacked, at once proceeds to thrust her ovipositor into the writhing body of her victim, depositing one or more eggs, according to the size of the living food-supply. When hatched, the larvæ devour and live upon their foster-parent, avoiding in a marvelous way the vital parts of their victim, whose life is most accurately timed to last until its young tormentors are full grown, and not beyond. At one time, we were led to believe in occasional instances of the instinct of female ichneumons being at fault, by observing them apparently ovipositing upon the dry shells of pupæ from which the butterflies had escaped. This, however, we subsequently found to be an erroneous idea, the fact of the matter being that the caterpillar upon which the parent ichneumon had laid her fatal egg had had time, before the full development of the young ichneumon grub, to turn to the pupal stage. What, then, we saw was the young ichneumon-fly just emerged from the dry pupal case, the contents of which it had first devoured in its own larval stage, then, itself turning to a pupa, it had lain, thus doubly incased, until, having broken forth a perfect fly, it rested upon its late prison, awaiting sufficient strength to come to its wings. What a wooden horse of Troy such a chrysalis would prove, if introduced into the breeding establishment of a collector!

Other members of the ichneumon tribe do not actually insert their eggs into the destined food-supply of their young; but, as it were, going deeper into calculation of future events, content themselves with laying them in close proximity to the eggs of some member of the tribe upon which it is their mission to prey.

There is an old saying:

> "Big fleas have little fleas
> Upon their backs to bite 'em;
> Little fleas have smaller fleas,
> So on *ad infinitum*"—

which is very true, inasmuch as from the great humble-bee down to the tiniest corn-thrips—a mere speck of dust to the naked eye—all insects have their parasites, and generally their own special species of ichneumon, to prevent their over-increase and to preserve the due balance of nature. There is a species of longicorn beetle, found in Pennsylvania, which feeds upon the tender bark of young hickory-shoots. When laying-time arrives, the female, having deposited her eggs in cavities perforated in the bark, carefully cuts a groove, about one-tenth of an inch wide and deep, round the shoot just below where her treasures lie. The object, or rather we suppose we ought to say the consequence, of this act is the withering and decay of the shoot, a provision for the sustenance of her young, which, when in their larval state, live upon dead wood! This remarkable insect is called the hickory-girder from the above-mentioned habit, which, we think, is one

of the most extraordinary instances of foresight, through a mere blind instinct, that have ever come under observation.

The gadfly (*Œustrus equi*), whose larvæ are the bots which inhabit the intestines of the horse, gains for her progeny that comfortable position by entrapping the animal itself into introducing her eggs within its stomach. For this purpose, she lays her eggs upon such portions of the horse's body as he is in the habit of frequently licking, such as knees, shoulders, etc. The unerring nature of her instinct is shown by the fact that she never chooses as a nidus any portion of the body which the horse is unable to reach with its tongue. Having thus been introduced into their natural feeding-grounds, the bots there pass their larval existence, until, it becoming time for them to assume the pupal form, they go forth with the animal's dung to reach the earth, burrow into it, and therein pass the insects' purgatory.

Again, one of the grain-moths (*Gelechia cerealella*) shows remarkable instinct in adapting itself to circumstances according to the time of year when it has to deposit its eggs. The first generation of these moths, emerging in May from pupæ which have lain in the granaries through the winter, lay their countless eggs upon the as yet ungathered corn, upon which their young play havoc until, having passed through the necessary stages, they come out in the autumn as the second generation amid the now stored-up grain. Now, however, their instinct prompts them, not, like the first generation, to go forth to the fields to seek the proper nest and future nourishment of their young, but bids them deposit their eggs upon the store of wheat ready at hand. Thus, two following generations of the same insect are led by their instincts to different habits to suit the altered and, in the last case, unnatural position of their infants' destined food-supply.

The interesting mason-wasp, having with great care and skill bored out a cylindrical hole in some sunny sand-bank, deposits at the bottom of this refuge her eggs. Next, provident mother as she is, she seeks out about a dozen small caterpillars, always of the same species, and immures them alive in the pit, as food for her cruel children. In making her selection of grubs to be thus buried alive, she rejects any that may not have reached maturity; not, we imagine, upon the score of their not being so full-flavored, but because, when not full-grown, they require food to keep them alive; whereas, when of mature age, they will live a long time without nourishment, ready to turn to chrysalides when opportunity occurs.

These are but a few of the instances which might be adduced in illustration of this foresight in insects, which compensates for their not being allowed in person to superintend the welfare of their offspring. In many cases, it would be better for human progeny were their parents thus endowed with an unerring instinct, rather than with an uncertain will.—*Chambers's Journal.*

SKETCH OF M. DE QUATREFAGES.

JEAN LOUIS ARMAND DE QUATREFAGES DE BRÉAU was born at Berthezeme, near Villerauge (Gard), France, February 10, 1810. His family was of the Protestant faith, and allied to the family of the publicist La Baumelle. His father was an educated agriculturist, who had served with distinction in Holland previous to the Revolution, but had returned to France on the breaking out of war between the two countries. Having received careful elementary instruction, young Quatrefages entered the medical course at Strasbourg, where he received the double diploma of Doctor of Medicine and Doctor in Science. On November 29, 1829, he sustained a thesis on the "Theory of a Cannon-Shot"; the next year he published at Strasbourg a work on aëroliths; and in 1832 a medical thesis on "Extraversion of the Bladder." He was appointed an examination preparator of chemistry to the Faculty of Medicine at Strasbourg; and at a later period established himself at Toulouse, where he brought the study of the natural sciences and medical practice to the front, and published a number of articles in the "Journal of Medicine and Surgery" of Toulouse, and memoirs in the "Annals of the Natural Sciences" from 1834 to 1836. His essay on the "Axodontes," published in 1835, was the subject of a favorable report by a Commission of the Academy of Sciences, and attracted attention to his capacity as a naturalist. At the end of 1838, M. de Quatrefages was called on the nomination of M. de Salvandy, then minister, to the chair of Zoölogy in the Scientific Faculty of Toulouse; but that provincial town not offering the conveniences he desired for pursuing the researches on which he had become engaged, he resigned his position there in a short time and went to reside in Paris, where he enjoyed the friendship and had the assistance of M. Milne-Edwards, and, supporting himself by means of his books and the scientific articles he wrote for the periodical press, was able to pursue his studies with ardor and to publish the results of them.

In 1850, he was appointed Professor of Natural History in the Lycée Napoléon. In April, 1852, he was elected a member, in the Zoölogical Section of the Academy of Sciences, where he took the place of Savigny. In August, 1855, he was called to the chair of Anthropology and Ethnology in the Museum of Natural History; and it is in these fields of science that the work by which he is most distinguished has been performed.

In 1872 M. de Quatrefages participated in the organization of the French Association for the Promotion of Science which that year held its first meeting at Bordeaux, and in the absence of the designated president, Claude Bernard, who was prevented by the state of his health from attending, served as acting president. His opening ad-

dress is described in "Nature" as having been "a very stirring and noble one, full of sound sense as to the recent humiliation and present condition of France, enthusiasm toward science, and faith in it as one of the most powerful regenerators of the country. "Science is at present supreme," he said; "she is becoming more and more the sovereign of the world." And he believed that it would be only when all ranks and classes of the people, rulers and ruled, were thoroughly imbued with the scientific spirit and were guided by scentific knowledge that France would ever again take and maintain the supreme place in the world which she ought to hold.

At the second meeting of this Association, held in August, 1873, at Lyons, M. de Quatrefages was president. In his opening address he pointed out the almost inconceivable advance that science had made during the past century, and the importance of scientific education. In speaking of the latter subject, he said that the devotees of literature accused Science of stifling the imagination. "'She kills,' they say, 'the ideal, and stunts intelligence by imprisoning it within the limits of reality; she is incompatible with poetry.' The men who speak thus have never read Kepler the astronomer, Linnæus the naturalist, Buffon the zoölogist, Humboldt the universal *savant*. What! Science stifle sentiment, imagination, she who brings us every hour into the presence of wonders! She lower intelligence, who touches on all the infinities! When literary students and poets know Science better, they will come and draw from her living fountain. Like Byron of our time, like Homer of yore, they will borrow from her striking imagery descriptions whose grandeur will be doubled by their truth. Homer was a *savant* for his time. He knew the geography, the anatomy of his era; we find in his verses the names of islands and capes, technical terms like *clavicle* and *scapula*. None the less, he wrote the 'Iliad.' No, the study of science will never suppress the genius of an inspired poet, of a true painter, of a great sculptor. But she will bring more light to the path of an erring soul. She will, perhaps, transform into a wise man, or at least into a citizen useful to himself and others, one who without her would only have been one of those pretended incomprehensible geniuses, designed to perish of misery, of impotency, and of pride. While fully admitting the important place of literature in education, he would wish to see children initiated at an early age into the facts, the ideas, and the methods of science.

"Governments, such as they have hitherto been, have almost always acted as if they had no need for the men who study Nature and her forces. But when any critical or important event occurs, then it is found necessary to appeal to them. Of whom are the juries of international exhibitions composed? No doubt each state sends its worthy merchants, its tried chiefs of industry, its eminent agriculturists, but it also, and above all, sends its men of science. At these important times peoples are comparing their real strength, and each feels that

it is for its honor in the present and its prospects in the future that the truth should appear; and to enlighten them, whether it be concerning cannons or silk-manufactures, telescopes or crystals, jewelry or hardware, it is felt that science is indispensable, and men of science are appealed to."

Beginning with 1842, M. de Quatrefages made a number of scientific voyages along the coasts of the ocean and the Mediterranean Sea, and in Italy and Sicily, which furnished him with the materials for a series of brilliant articles in the "Revue des Deux Mondes," some of which were afterward published (1854) in a volume entitled "Souvenirs d'un Naturaliste" ("Recollections of a Naturalist"). This was published in London in 1857 as "Rambles of a Naturalist on the Coasts of France, Spain, and Sicily." Among other works which he has published on subjects of general zoölogy are, translating the titles: "Considerations on the Zoölogical Characteristics of the Rodents" (1840); "On the Organization of the Invertebrate Animals of the Coasts of the British Channel" (in the "Annales des Sciences Naturelles," 1844); "Researches on the Nervous System, the Embryogeny, the Sensory Organs, and the Circulation of the Annelids" (ibid., 1844–1850); "On the Affinities and the Analogies of Earth-Worms and Leeches" (ibid., 1852); "On the Natural History of the Teredos" (ibid., 1848 and 1849). Invited by the Academy of Sciences to investigate the silk-worm disease, he published in 1859 "Studies," and in 1860 "New Researches on the Present Diseases of Silk-Worms." "Natural History of Marine and Fresh-Water Annelids" (1866); and "La Rochelle and its Environs" (1876). The later studies of M. de Quatrefages have been more predominantly in the direction of anthropology; and it is as an anthropologist that he is best known. In "The Human Species," which appeared in 1879, he took distinct ground in favor of the unity of the race.

The question whether there exists a fundamental distinction between man and animals he answered in the affirmative, and justified his position by the three considerations that man has the perception of moral good and evil, independently of all physical welfare and suffering; that man believes in superior beings who can exercise an influence over his destiny; and that he believes in the prolongation of his existence after this life. The author's idea of the moral and religious quality in man is conveyed in the sentence, "The learned mathematician, who seeks by the aid of the most profound abstractions the solution of some great problem, is completely without the moral or religious sphere into which, on the contrary, the ignorant, simple-minded man enters when he struggles, suffers, or dies for justice or for his faith." The different colors of men are regarded as results of accidental variations. Concerning the origin of the human species, M. de Quatrefages does not hesitate to reply in the negative to the question whether it is possible to explain the appearance on our globe of a being "which

forms a kingdom to itself." Concerning his attitude on this and kindred subjects, Mr. W. L. Distant remarks, in "Nature," that "it is to be noted how such an eminent naturalist as our author is still opposed to Darwinism, which in this section receives copious treatment, and some of the grounds principally given for its rejection are to many minds who embrace it the reasons of their faith." In treating of the psychological characteristics of the human species, M. de Quatrefages combats some of the views advanced by Sir John Lubbock, and criticises the common disposition to regard all sense of honesty as absent in certain races, as assuming too much on insufficient data. He says, on this point: "Nothing is more common than to hear travelers accuse entire races of an incorrigible propensity for theft. The insular populations of the South Seas have, among others, been reproached with it. These people, it is indignantly affirmed, stole even the nails of the ships! But these nails were *iron*, and in these islands, which are devoid of metal, a little iron was, with good cause, regarded as a treasure. Now, I ask any of my readers, supposing a ship with sheathing and bolts of gold, and nails of diamonds and rubies, were to sail into any European port, would its sheathing or its nails be safe?" In a paper on "The Crossing of the Human Races," which was published in "The Popular Science Monthly" for June, 1880, M. de Quatrefages took distinct ground, in opposition to the views of most of his fellow-anthropologists, that mixture of stocks, where the environment is favorable to its full operation and development, is for good. But he bears in mind that "the aggregation of physical conditions does not in itself alone constitute the environment. Social and moral condition have an equal part in it." If real marriages take place between the races, he adds, and their offspring are placed upon a footing of equality with the mass of the population, "they are quite able to reach the general level, and sometimes to display superior qualities. All of my studies on this question have brought me to the conclusion that the mixture of races has in the past had a great part in the constitution of a large number of actual populations. It is also clear to me that its part in the future will not be less considerable. . . . The people of mixed blood already constitute a considerable part of the population of certain states, and their number is large enough to entitle them to be taken notice of in the population of the whole world." He concludes this paper with the obervation that the facts cited in it show that man is everywhere the same, and that his passions and instincts are independent of the differences that distinguish the human groups.

Other works of M. de Quatrefages are: "Comparative Physiology; Metamorphoses of Man and Animals" (1862); "The Polynesians and their Migrations" (1860); "Report on the Progress of Anthropology" (1867); "Darwin and his French Precursors" (1870); "The Prussian Race" (1871); and "Crania Ethnica," an important work prepared by him in connection with M. Hamy.

EDITOR'S TABLE.

THE BAD LOGIC OF MATERIALISM.

IN a preceding article we used the expression, "healthy materialism," for that view of things which frankly recognizes and makes practical allowance for the dependence of psychical phenomena upon material conditions, without undertaking in the least to decide the question as to the relations ultimately existing between mind and matter. This view we represented as at once conservative and progressive: conservative, in the limits which it recognizes as set to intellectual activity and in the prudence it enjoins in regard to all intellectual operations; progressive, in the aid which it affords toward securing the proper material basis for all intellectual and moral effort, and in the economy of labor which thence results.

This is not the materialism, however, against which the world has so strong a prejudice. The greatest sticklers to-day for a spiritualistic philosophy would make no objection to acknowledging the facts on which materialism, in the sense above described, is founded—that health of body is, other things being equal, the best condition for health of mind; that a certain relation must be observed between physical nutrition and repair on the one hand and intellectual effort on the other; that the quality, both of thought and of feeling, depends largely on the condition of the physical functions, and so on. No, these truths have been too much ignored in the past, but they are widely advocated to-day by teachers of unblemished orthodoxy; nevertheless, a strong feeling against what is called "materialism" survives. The common feeling on the subject is that materialistic theories tend to rob human life of a certain dignity, to undo something that the ages have wrought. Men seem to exclaim, in the words of Shelley:

> ". . . What can they avail?
> They cast on all things surest, brightest, best,
> Doubt, insecurity, astonishment."

The explanation and, as we think, the justification of this feeling lies in the fact that materialism as held, and more or less blatantly professed, by many, is in effect an attempt to explain higher orders of phenomena by lower, to ignore the complexities of existence, and to reduce everything to a kind of mechanical basis. Starting from the assumption that matter is not only the cause of everything, but is everything, they proceed to interpret matter according to the lowest and simplest properties it manifests. They want what Mr. Stallo calls a mechanical explanation of the universe; but, not content with that, they strive as much as possible to blind themselves to the fact that, while mechanical relations may lie at the basis of all things, in the actual evolution of the universe, relations of a much higher and more complex order have been established. We have heard men argue thus: "Matter is everything and everything is matter; morality can not inhere in or be any property of matter, therefore morality is an illusion, a prejudice, a superstition." Exception might of course be taken here to the major premise that matter is everything; matter, according to Mr. Spencer, not to mention less advanced thinkers, being simply one mode of the manifestation of the Unknowable Cause of all things. But, waiving this objection, and meeting the materialist on his own ground, we might say: "You affirm that matter is coextensive with existence, that whatever we have any knowledge of is some form

of matter. Excellent! A good way, therefore, to get as comprehensive and adequate an idea as possible of what matter is, would be to consider it in all its forms; in other words, to consider its total outcome. Among the realities of existence, nothing is more real than thought and emotion. We must, therefore, make provision for these in our conception of matter. But thought and emotion give rise to morality; and, if matter is to include everything, then must we concede to it a certain moral element. Matter, therefore, is something which not only contains 'the promise and potency' of every kind of human excellence, but which manifests itself in the highest phenomena of human life just as distinctly as in the laws of mechanics and physics. Our conception of matter is thus made to embrace and embody all that before had been divided between mind and matter. We can no longer, therefore, view matter as something essentially limited to lower and simpler manifestations. Our conception of it is enlarged and dignified just in proportion to what we have made it absorb. It is not apparent, therefore, that any dignity or value which before had attached to man's mental and moral life is in any way impaired by your representation of it as a function of matter. You have simply by your definition raised matter to a level with the highest phenomena of the universe, and stamped it with the character of equivalence with those phenomena. We may not accept your metaphysics, but we do not think they touch the essential dignity of those parts of human life which, perhaps, it was your intention to degrade in our estimation."

The trouble with "materialists" of a certain stamp lies precisely here: they think that by proclaiming the universality of matter they can bring everything down to the level of the lowest, i. e., the simplest, phenomena that matter displays; that they can dethrone love, rob honor of its luster, and virtue of its bloom. They say: Everything is matter, and matter should be interpreted in its lowest terms—in terms, say, of mechanics. But, if any partial interpretation is to be adopted, why interpret matter in its lowest rather than in its highest terms? As well ignore the laws of mechanics and physics and chemistry as the laws of mind, the laws of morality, the laws of society. "Materialism," in the sense indicated, is simply a willful tearing down of what nature has set up. In the realm of Nature, including the life of man, we discover an ascending series of laws and relations. The simplest and most universal relations are those of space and number. Above these, in complexity and speciality, are those of physics; above these, again, those of chemistry. And so we pass on to biology, psychology, and sociology. It would be the merest folly to take one's stand, say, on the laws of mathematics or mechanics, and to refuse to recognize any higher speciality or complexity in phenomena than these will account for. It would be folly for the chemist to refuse to hear of a science of physiology, simply because the problems and methods of physiology transcended those of his own science. It would be folly of the same kind for the physiologist to insist that his methods were adequate to the solution of all questions in psychology and ethics; or, on the other hand, to deny the validity of the methods employed in the latter sciences because they were not identical with those with which he was most familiar. We can conceive that, at the moment of the first formation of every higher science, there might be those who, in the supposed interest of established methods and canons, would call in question the phenomena upon which the new science was being constructed, or deny their special character. This would be "materialism" according to the conception of it here put forward—i. e., *an insist-*

ing on the interpretation of phenomena in lower terms than are suited to their special character. "Materialism" in this sense stands in the way of scientific progress, for, while the Newtonian maxim, "*Hypotheses non fingendæ sunt præter necessitatem*" (hypotheses are not to be framed beyond our actual need for them), is a very valuable one, the whole life of science is bound up in the liberty to frame hypotheses *according to* our needs.

We are perhaps now in a position to understand why materialism, in one phase at least, has excited so much suspicion and aversion. The conservative and the progressive instincts of mankind are at once against it. Men do not wish to be argued out of their perceptions of beauty, or out of their admiration for the higher human sentiments and virtues. But they would be argued out of everything of the kind, if they once consented to the principle that the true expression for any given phenomenon is the lowest that it admits of. "Tell love it is but lust!" says Sir Walter Raleigh, or whoever was the author of that pessimistic poem, "The Lie," which has sometimes passed under Raleigh's name. Such is the inspiring message which the materialism we are now considering sometimes feels called upon to deliver to the world. Sexual attraction is the physical basis of love; *ergo*, all love must be mere physical appetite. But the world knows that upon that basis great and glorious things have been built, and that love in its higher forms bears about as close a resemblance to lust as the perfect flower does to the soil from which it springs, or the seed in which it once lay imprisoned. The reasonable request of decent people is that things be left as God or Nature has arranged them; that what has been raised, by no act of man's, into beauty and honor, should hold its status unassailed by the destructive hands of sophistical levelers. Teach us the truth, they say; show us the unity of Nature; show us the analogies of type and function that proclaim and illustrate that unity; but do not seek to promote a morbid confluence of all the elements of thought by trying to make us think in the same terms of the most diverse facts. It is in its character of the universal denier that materialism encounters such hostility. It does not want to recognize the accomplished facts of Nature in any region higher than the lowest. But the facts survive, and will survive, all attempts to deny their existence. Man has come, and man is an intellectual and moral being. This is the great, irreversible fact which gives the lie to all pessimistic theories, and which renders nugatory all attempts to see nothing in the universe but matter and motion.

THE CONFLICT OF LANGUAGE-STUDIES.

THAT able quarterly, the "Bibliotheca Sacra," contains an article in its January issue which, considering the scholarly traditions of this old and high-toned periodical, is significant of wholesome progress. It is a defense of the claims of modern languages as against the ancient in the curriculums of college-study. The paper is entitled "A Plea for a Liberal Education," and is by James King Newton, Professor of the German and French Languages and Literature at Oberlin. For the benefit of such of our readers as may be interested in this important question, we present some of the considerations urged by this independent writer.

The ground taken by Professor Newton is substantially that which we have maintained throughout in "The Popular Science Monthly." Of course, he will be at once ranked, as we have been, among the enemies of the classics—a proceeding entirely without justification. He simply but firmly contends for the educational rights of German and French, as against the arrogant and extravagant pretensions put forward by

the Greek and Latin. He neither denies the value or importance of the classical languages, nor contemplates their exclusion from the college curriculum; but he condemns the vicious educational theories that have been put forward to vindicate and maintain their overshadowing supremacy. He is not an enemy of the classical languages, who opposes them as mere blindly venerated superstitions; but he, on the contrary, is their best friend, who would reduce them from this injurious pre-eminence, and leave them to stand on their merits for what they are worth. As important parts of learning to those who devote themselves to scholarship, or as interesting subjects to those who are attracted by their tastes to pursue them, or as badges of distinction in culture to those who prize them for such a purpose, or as bread-and-butter studies for the clerical profession, the dead languages have their defensible uses; but as a superior means of training the human mind, to be forced on everybody who goes to college and aspires to a liberal education, and as, consequently, disparaging other subjects, and standing in the way of far more important knowledge, they are to be resisted and reprobated as of evil influence by every friend of sound and rational education.

In the progress of the modern classical controversy, the practical issue has been most sharply made between the Greek and the German, and this is the issue to which Professor Newton's paper is mainly devoted, although it takes up various collateral points. He says:

> Almost without exception in this discussion, the Greek has counted itself, and been counted by its opponents, on the side of the abstract, the disciplinary; while the modern languages have ranged themselves, or been ranged by their opponents, upon the side of the practical merely; grouped in with the sciences as useful knowledge, but lacking all, or nearly all, disciplinary value. But there are not a few fallacies which place the modern languages in opposition to the ancient, that need to be exposed, in order that, in the scheme of a liberal modern education, they may secure their proper time and place. It can easily be shown that many of the arguments used in favor of Greek as against German, both as to discipline and culture, are as true of the German as of the Greek.

Professor Newton then takes up the question of the alleged superiority of the Greek over the German in cultivating the attention and training the memory, and thoroughly exposes the fallacy of the claim. In regard to the processes involved in the exercise of translation, he says:

> I believe it can be shown that the power of analysis and the power of synthesis are as much needed, and as much cultivated, by a thorough mastery of the German as of the Greek. For what is translation as a mental process? It is necessary, in the first place, that the mind grasp a thought expressed in words whose relations are shown by terminations, or by order of arrangement, or by particles; by any one, or by all three of these. Then, in the second place, this thought must be wrought over in the mind, fused, and poured out again into the molds or forms of the language into which one is translating, in strict accordance with its vocabulary, its idiom, and its spirit. And the same use of the same faculties is required in every possible translation. But the facility acquired by long practice in translating from one language must not be compared with the stumbling efforts of a beginner in translating from another. Of course, the same proficiency in translating can not be gained in three terms of German as in twelve terms of Greek. And it is not knowing German to be able to work one's way through a foot-note, and just miss the point from not knowing the force of a modal auxiliary.

For various cogent criticisms made by Professor Newton on the alleged superiority of Greek for general disciplinary effect we have no space to speak, but must reproduce what he says about the study of English:

> In all these later arguments in regard to the disciplinary efficiency of the Greek there is the insinuation, or the explicit statement, that all modern languages, the English especially, are worthless, or worse than worthless, for purposes of discipline. A writer in the "Atlantic Monthly" for January, 1884, has

much to say on this subject, which has been more clearly said elsewhere; but he says plainly this one thing, which is often only hinted at or taken for granted: "The modern languages do not contain material out of which to construct a logical grammar like theirs" (the ancient languages). "What does English, French, or German grammar amount to? Simply *débris* of the classical languages, mixed with barbaric elements."

If this be true, we had better give up the study of Greek, and emulate the method of the Greeks, who made their language what it is by studying the Greek alone. They wrought upon it till it served their nicest uses. If our English be but a mixture of "*débris*" and "barbaric elements," it is high time for us to leave off studying other languages, both dead and living, and work upon our own until we make it somewhere nearly equal, as a thought-conveying medium, to the languages from which we are compelled to translate; for it is intellectual suicide to translate from a fine language into an incompetent one.

But this statement in regard to the English is not only not just, it is utterly false and misleading. We do, indeed, need to go to work upon it to realize what an incomparable language we have. Hear Jacob Grimm, prince among philologists:

No one of all the modern languages has acquired a greater force and strength than the English, through the derangement and relinquishment of its ancient laws of sound. The unteachable (nevertheless learnable) profusion of its middle-tones has conferred upon it an intrinsic power of expression, such as no other human tongue ever possessed. Its entire, thoroughly intellectual, and wonderfully successful foundation and perfected development issued from a marvelous union of the two noblest tongues of Europe, the Germanic and the Romanic. Their mutual relation in the English language is well known, since the former furnished chiefly the material basis, while the latter added the intellectual conceptions. The English language, by and through which the greatest and most eminent poet of modern times—as contrasted with ancient classical poetry—(of course I can refer only to Shakespeare) was begotten and nourished, has a just claim to be called a language of the world; and it appears to be destined, like the English race, to a higher and broader sway in all quarters of the earth. For in richness, in compact adjustment of parts, and in pure intelligence, none of the living languages can be compared with it—not even our German, which is divided even as we are divided, and which must cast off many imperfections before it can boldly enter on its career.

Yet, while foreigners are writing thus of our language, we are telling each other and our students—who happily do not always believe us—"that the Greek is more perfect; that the Latin is more polished; that the German is stronger; that the French and Italian are more musical; and we seem to be studying other languages, not to train ourselves to see and use the beauty and strength of our own, but only to cultivate a contempt for it.

Pursuing this idea of the claims of modern languages, Professor Newton quotes various authorities as to the great philological importance of their more systematic study, and he gives a strong passage from Max Müller in which it is declared that "before the tribunal of the science of language the difference between ancient and modern languages vanishes. . . . Where, except in these modern dialects, can we expect to find a perfectly certain standard by which to measure the possible changes which words may undergo, both in form and meaning, without losing their identity? . . . where, again, except in the modern languages, can we watch the secret growth of new forms, and so understand the resources which are given for the formation of the grammatical articulation of language?" Professor Newton says: "I have brought forward these arguments to show that there are reasons to be adduced for studying the modern languages, other than that they are so 'easy'; that there are reasons *per se;* and that in every college for either drill or culture the modern languages should have a respectable space and a respectful recognition. As it is now, every young man who elects the one term of French, or even the three terms of German, must count over against their being 'easy' the popular estimation that they are 'boarding-school' studies."

Professor Newton is of opinion that the tenacious adherence to classical traditions in regard to the study of lan-

guage is certain to prove injurious if not disastrous to our American colleges. Progress of knowledge, the spirit of the age, and the requirements of the American people must count for more than has been yielded to them if these institutions are to increase in influence and prosperity. He says:

The demands of our own polyglot people are to be heard, if we wish them to come to school. If we of the colleges decide that we wish no one to come but those who will take the one old road, the numbers in the colleges will not greatly increase, even though the population of our country quadruples. For we must judge of the future by the past in this matter. The population of the United States, as shown by the census, increased during the ten years, between 1870 and 1880, from thirty-eight and one half millions to fifty millions—an increase of twenty-three per cent. But the increase in number of students, for the same time, in twenty of the oldest, leading colleges, was less than three and one half per cent. Something is keeping the sons of our well-to-do common people out of the colleges. It is not the hard work. They work much harder on things that pay less in profit and position. It is not that they are not hungry for knowledge. They go greedily after husks even. But among the thousands of things they want to know and need to know, in order to have part in the life they are to lead, Greek seems to them of the least necessity. And it is because this bar of the Greek lies across the path to a college education that the crowd is turned from college halls. We of the cloisters may say, it should not seem of small importance to sensible people; but it does seem so. And we are causing thousands every year to lose all the rest of a college training, because we persist in making Greek the one, universal, inexorable test of admission to college.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, VOL. XLVIII.

ORIGIN OF CULTIVATED PLANTS. By ALPHONSE DE CANDOLLE. New York: D. Appleton & Co. Pp. 468. Price, $2.

ALTHOUGH a thoroughly popular work interesting to everybody, this volume is nevertheless a monument of laborious and learned research. Its author is not only one of the most eminent botanists of the age, but he has been for many years especially devoted to this subject. He published an extensive work thirty years ago on "Geographical Botany," one chapter of which was devoted to the "Origin of Cultivated Plants," and he has since pursued the subject so systematically and perseveringly that the field is now his own. The present book, however, is entirely new, and gives what is known of the history of nearly all plants which are cultivated, either on a large scale for economic purposes, or in fields, orchards, and kitchen-gardens.

The work, as may be supposed, has been one of very great difficulty. Lack of knowledge, doubtful statements, and, what is worse, long sanctioned and established error, have proved formidable difficulties in the way of research. Plants, like men, have not only traveled over the globe from region to region, undergoing changes in their migrations into new environments, but they have been directly modified by domestication, so that only thorough botanical knowledge can trace their lineage and throw light upon their origin. In some cases the original wild species are probably extinct, and in other cases the cultivated varieties have lapsed into the wild condition, so that the problem of identification is liable to be much obscured. But greater difficulties still have arisen from the fact that botany is a modern science of which the ancients knew very little, so that their descriptions are imperfect and untrustworthy. The embarrassments of the research are, moreover, heightened by that revolution in regard to the validity of evidence which science has wrought in recent times. All statements have to be questioned and sifted, and loose opinions thrown aside by the more exacting standards of proof which men of science now recognize. On these points, and with reference to the general plan of his inquiries, Professor De Candolle remarks:

I have always aimed at discovering the condition and the habitat of each species before it was cultivated. It was needful to this end to distinguish from among innumerable varieties that which should be regarded as the most ancient, and to find out from what quarter of the globe it came. The problem is more difficult than it appears at first sight. In the last century and up to the middle of the present, authors made little account of it, and the most able have contributed to the propagation of erroneous ideas. I believe that three out of four of Lin-

næus's indications of the original home of cultivated plants are incomplete or incorrect. His statements have since been repeated, and, in spite of what modern writers have proved touching several species, they are still repeated in periodicals and popular works. It is time that mistakes, which date in some cases from the Greeks and Romans, should be corrected. The actual condition of science allows of such correction, provided we rely upon evidence of varied character, of which some portion is quite recent, and even unpublished; and this evidence should be sifted as we sift evidence in historical research. It is one of the rare cases in which a science founded on observation should make use of testimonial proof. It will be seen that this method leads to satisfactory results, since I have been able to determine the origin of almost all the species, sometimes with absolute certainty, and sometimes with a high degree of probability.

The investigations of De Candolle assume a new and enlarged interest from the results of modern biological progress in regard to the transformations of species, and the vast periods of time during which organic development and mutations have been going forward. The great problem was fundamentally changed with the abandonment of the old view regarding the immutability of species. It was under the careful study of plants that that view first broke down, and from that time a radically new method has prevailed in the study of the vegetable kingdom. From this point of view the historical question of the origin of cultivated plants not only became a modern question, belonging, indeed, to the present age, and incapable of earlier solution, but it connects itself with vast periods of change, and is linked on to the largest considerations of the economy of life upon the earth. We quote some further instructive observations of our author in regard to important particulars of his research:

I have endeavored to establish the number of centuries or thousands of years during which each species has been in cultivation, and how its culture spread in different directions at successive epochs. A few plants cultivated for more than two thousand years, and even some others, are not now known in a spontaneous, that is, wild condition, or at any rate this condition is not proved. Questions of this nature are settled. They, like the distinction of species, require much research in books and herbaria. I have even been obliged to appeal to the courtesy of travelers or botanists in all parts of the world to obtain recent information. I shall mention these in each case, with the expression of my grateful thanks.

In spite of these records and of all my researches there still remain several species which are unknown wild. In the cases where these come from regions not completely explored by botanists, or where they belong to genera as yet insufficiently studied, there is hope that the wild plant may be one day discovered. But this hope is fallacious in the case of well-known species and countries. We are here led to form one of two hypotheses: either these plants have since history began so changed in form in their wild as well as in their cultivated condition that they are no longer recognized as belonging to the same species, or they are extinct species. The lentil, the chick-pea, probably no longer exist in nature; and other species, as wheat, maize, the broad bean, carthamine, very rarely found wild, appear to be in course of extinction. The number of cultivated plants with which I am here concerned being 249, the three, four, or five species, extinct or nearly extinct, is a large proportion, representing a thousand species out of the whole number of phanerogams. This destruction of forms must have taken place during the short period of a few hundred centuries, on continents where they might have spread, and under circumstances which are commonly considered unvarying. This shows how the history of cultivated plants is allied to the most important problems of the general history of organized beings.

From these considerations it will be seen that the present volume is of capital interest to all concerned with botanical science. It is an authoritative digest of facts to be nowhere else found, and has been executed with the strictest fidelity to the original sources of information. The fullness and minuteness of the references to works consulted greatly enhance the scientific value of the volume, and will undoubtedly be much appreciated by botanical students.

But, as we remarked at the outset, the book is entirely popular, and thoroughly intelligible to common readers. Its plan is simple. Part I consists of two chapters of general preliminary remarks as to I, "In what Manner and at what Epochs Cultivation began in Different Countries"; and II, "Methods for discovering or proving the Origin of Species." In Part II, the main portion of the work, the divisions are simple and practicable, as follows: I, "Plants cultivated for their Subterranean Parts, such as Roots, Tubercles, or Bulbs"; II, "Plants cultivated for their Stems or Leaves"; III, "Plants cultivated for their Flowers, or the Organs which envelop them"; IV, "Plants cultivated for their Fruits"; V, "Plants cultivated for their Seeds." At the close there is a valuable table summing up the general results, which is followed by a careful index. All the

plants described are given under their common names.

It would seem that all intelligent people should desire to be informed concerning the history of such familiar things as the plants that are used for daily food; but the intellectual interest of the subject is heightened when we find that this common subject is involved largely in the progress of human civilization.

THE NEW PHILOSOPHY. By ALBERT W. PAINE. Bangor, Me.: O. F. Knowles & Co. Pp. 168. Price, $1.

MR. PAINE in this book presents a new theory respecting the connection of the two worlds in which he believes man has his existence, and their intimate relations to each other, based on the psychical and so-called spiritual phenomena which have recently attracted attention. He supposes that man while an inhabitant of this world is composed of two factors, soul and body, each of which is complete in itself and separate from the other as regards constituent form, but corresponding with the other in all essential particulars, the body being permeated by the soul in every minutest part, and that the separation from each other is death, upon which the soul becomes wholly independent. He also proposes a theory of electricity, the essential feature of which is that that agent is closely related with the great law of spiritual existence.

TEXT-BOOK OF BOTANY, MORPHOLOGICAL AND PHYSIOLOGICAL. By JULIUS SACHS, Professor of Botany in the University of Würzburg; edited, with an Appendix, by SYDNEY H. VINES, M. A., D. Sc., F. L. S., Fellow and Lecturer of Christ's College, Cambridge. Macmillan & Co. Second edition. Pp. 980. Price, $8.

WE noticed this important work upon its first appearance, and recognized its position as foremost among the standard treatises on botanical science of the present day. The work is intended to put the student in full possession of the present state of knowledge upon the subject, and, besides describing the phenomena of plant life which are already accurately known, it indicates also very fully those theories and problems in which botanical research is at present especially engaged. Detailed discussions of questions of minor importance have been avoided, and the historical development of botanical views has also been omitted, that the entire space of the work may be devoted to a representation of the existing condition of the science.

No change in the plan of the work has been made in this new edition, nor any modification of its leading features. Some minor alterations and additions have been introduced, and something has been done to improve and perfect the translation. A few notes are appended to the volume, embodying some of the very latest results in botanical research. The work is elegant in form and complete in its treatment, and may be commended as the most adequate treatise for the thoroughgoing botanical student, and at the same time one of the best books we have for general reference in a library.

RUDIMENTARY SOCIETY AMONG BOYS. By JOHN JOHNSON, Jr. Baltimore: N. Murray. Pp. 56. Price, 50 cents.

IN this paper the editor of the Johns Hopkins University "Studies in Historical and Political Science" has consented to include a plot a little outside of the field which it was first intended to cultivate in those studies, and he has decided wisely. The paper describes the spontaneous organization of a community, and the growth of laws and established customs among a group of boys just brought together, almost from the wild state, at the school with which he was connected; and gives a study, from actual contemporary observation, of the manner in which, in all likelihood, the primitive societies grew up and became fixed. The school was the McDonough School, near Baltimore, to which is attached a domain of eight hundred acres, giving ample privileges for nutting and bird's-nesting and rabbit-trapping. In the beginning everything was common. The first to grasp a prize secured it. All is very different now. Conflicts came, and made rules necessary to avoid them. The rules were made by the boys' own action, as occasion arose for forming them; and now the property and the privileges are all parceled out, with fixed regulations for their tenure, transference, and descent. Classes have grown up of landlords and tenants, and there are monopolists and persons

who have no estates. A system of credits has been developed, with something like banks. And the McDonough School has become the epitome of a State, with its laws, and its vested interests, and its business methods, all systematically regulated, and the regulations a living force. The successive steps that have led up to this condition, the reason for each new measure, and the effect of it after it went into operation, are graphically described in the essay.

TOWN AND COUNTY GOVERNMENT IN THE ENGLISH COLONIES OF NORTH AMERICA. By EDWARD CHANNING, Ph. D. Baltimore: N. Murray. Pp. 57. Price, 50 cents.

THIS is another of that series of valuable studies in the development of our political history which the Johns Hopkins University is giving to the public in monthly monographs. It describes the manner in which the parochial, or town, and county organizations in the older colonies arose, from some or other of which the similar organizations of the newer States in their essential features were derived. The exact form which the local organization in each colony should assume is regarded as having depended upon the economic conditions of the colony; the experience in the management of local concerns which its founders brought from the mother-country; and the form of church government and local organization which was found expedient.

PREHISTORIC AMERICA. By the MARQUIS DE NADAILLAC. Translated by N. D'ANVERS. Edited by W. H. DALL. New York: G. P. Putnam's Sons. Pp. 566, with 219 Illustrations. Price, $5.

THE author of this work was already well known to students of archæology by the book previously published by him on primitive men and prehistoric times, in which were described the stone age of Europe and the early resting-places of the ancient inhabitants of the Old World. The good-will with which that work was received has led him to supplement it by tracing the analogous period in America. In carrying out this study, he has made good use of the investigations which have been undertaken in the United States, to which he fittingly acknowledges his obligations. As a result he has given a methodical and comprehensive treatise, constituting, perhaps, the most adequate presentation of the whole subject that has yet been made in a single volume. The present translation has been made with the author's sanction, and, with his permission, has been so modified and revised by the editor—who is recognized as an expert in this branch—as to bring it into harmony with the results of recent investigation and the conclusions of the best authorities on the archæology of the United States. In the final chapter the editor expresses his views as to the manner in which America was peopled, to the effect that it was done at different times by scions of different races. The completeness of the index deserves commendation.

THE ECLECTIC PHYSIOLOGY. By ELI F. BROWN, M. D. Cincinnati and New York: Van Antwerp, Bragg & Co. Pp. 189, with Plates.

THIS is a treatise prepared with special reference to its use in schools, and giving only such matter as seems needful to enable pupils fairly to master the subject, but with supplementary matter in notes. The study is made to proceed from the simplest, in a plain order of dependence, to the most complex parts: under each topic, attention is first given to the structure and use of parts; upon which the hygiene of the part follows closely. Attention is given to the care of proper sanitary conditions in the home, and to the discussion of habits; and the effects of narcotics and stimulants on the body and mind are set forth plainly and fully.

ICARIA: A CHAPTER IN THE HISTORY OF COMMUNISM. By ALBERT SHAW, Ph. D. New York: G. P. Putnam's Sons. Pp. 219. Price, $1.

THE purpose in this book is simply to present in full the history of a single communistic enterprise, without going into the discussion of the merits or demerits of communism, or into the consideration of any topic aside from the narrative. The author submits two particular reasons why this story should be told: First, it has never been told before, except in the most meager and inaccurate way, and is besides a peculiarly romantic and interesting one; second, because "as an example of communism in the concrete, Icaria has illustrative value

beyond all proportion to its wealth, membership, and success. Most of the communistic societies of the United States might better be studied as religious than as socialistic phenomena. . . . Icaria is an attempt to realize the rational, democratic communism of the Utopian philosophers, hence its value as an experiment."

THE ELEMENTS OF CHEMISTRY, INORGANIC AND ORGANIC. By SIDNEY A. NORTON, Ph. D. Cincinnati and New York: Van Antwerp, Bragg & Co. Pp. 504.

INTENDING his treatise to be used as a text-book, not as a manual for reference, Professor Norton has endeavored to select such chemical phenomena as represent the cardinal principles of the science, giving preference to those which are easily reproduced by the student, and which enter into the affairs of common life. He invites students to experiment, and encourages them, if they can not afford artistically made apparatus, to extemporize apparatus with bottles and tumblers and connecting tubes. The most essential thing in experimenting, he says, is the experimenter, who should know what he proposes to do, what are the means at his command, and how he intends to use them; and, chemistry being exact in its methods, he must remember that careless manipulation will not secure good results, and that such words as neutral, acid, basic, and excess, must not be neglected. In nomenclature, the rules of the London Chemical Society are observed; in notation, a flexible plan has been adopted; and, in the descriptions of elements, Mendelejeff and Meyer's classification has been followed.

REPORT OF AN ARCHÆOLOGICAL TOUR IN MEXICO, IN 1881. By A. F. BANDELIER. Boston: Cupples, Upham & Co. Pp. 326, with Twenty-six Plates.

THE report is one of the papers of the Archæological Institute of America, in cooperation with which Mr. Bandelier made his explorations, and is the second of the American series of its special reports. Besides the notes of the explorer's travel, it embraces his studies of and observations upon the archæological relics in the city of Mexico, the mounds of Cholula, and the interesting ruins of Mitla, all richly illustrated, largely from photographs.

SCIENCE IN SONG; OR, NATURE IN NUMBERS. By WILLIAM C. RICHARDS. Boston: Lee & Shepard. New York: Charles T. Dillingham. Pp. 131.

AN attempt to present various facts and principles of science in verse. Among the special topics sung in measured numbers are steam, electricity, the spectroscope, magnetism, various chemical elements, heat, astronomical phenomena, etc. The verse has considerable life and merit as verse, and the author's success justifies his belief that philosophy and poetry in union are not incongruous. The singer's bias is decidedly against the doctrine of evolution, which he appears to believe — mistakenly, as both sides are coming to conclude—is in some way hostile to the foundations of his religious faith.

REPORTS OF THE MEETINGS OF THE SCIENTIFIC ASSOCIATIONS HELD IN MONTREAL AND PHILADELPHIA, as given in "Science." Cambridge, Mass.: "Science" Company. Pp. 112.

ACCOUNTS of the proceedings of the recent meetings of the British and American Associations at Montreal and Philadelphia, with abstracts of the more important and interesting papers, including the presidential and vice-presidential addresses, were published in the consecutive numbers of "Science," from August 29 to October 3, 1884. These six numbers are here combined in a bound volume under the title given above, which, besides the abstracts mentioned, contains considerable other matter of scientific interest.

REPRESENTATIVE BRITISH ORATORS, with Introductions and Explanatory Notes. By CHARLES KENDAL ADAMS. New York: G. P. Putnam's Sons. Three volumes, pp. 318, 308, and 376. Price, $3.75.

THE object of this publication is to help show the great currents of political thought that have shaped the history of Great Britain during the past two hundred and fifty years, by bringing together the most famous of those oratorical utterances that have changed, or have tended to change, the course of English history. While the orations included — from masters of English oratory—are great as rhetorical efforts, it is not for this that they are given, but for their political significance. Eliot and Pym

formulated the grievances against absolutism out of which the Parliamentary revolution grew; Chatham, Mansfield, and Burke had to do with the principles of the foundation of American independence; Mackintosh and Erskine championed the freedom of juries and of the press; Pitt expounded the policy of continuous opposition to Napoleon; Fox pleaded for peace; Canning inaugurated the English foreign policy; Macaulay cogently advocated the "Reform Bill" revolution; Cobden brought on the blessing of free trade. In our own generation, Bright denounced the foreign policy of the empire; Beaconsfield expounded the principles of the Conservatives; and Gladstone formulated, as he now conspicuously represents, the doctrines respecting home and foreign affairs of the Liberals. It is the speeches in which are clearly declared these several principles, and which "at one time or another have seemed to go forth as in some sense the authoritative messages of English history to mankind," that are here brought together.

AN ELEMENTARY TREATISE ON ANALYTIC MECHANICS. By EDWARD A. BOWSER, LL. D. New York: D. Van Nostrand. Pp. 511.

PROFESSOR BOWSER'S work is designed as a text-book for students of scientific schools and colleges who have received training in the elements of analytic geometry and the calculus. The analytic method has been chiefly employed, though geometric proofs have been introduced where such were deemed preferable. The book consists of three parts: Part I, with the exception of a preliminary chapter, is devoted to statics; Part II is occupied with kinematics; and Part III treats of the kinetics of a particle and of rigid bodies. For the attainment of that grasp of principles which it is the special aim of the book to impart, numerous examples are given at the ends of the chapters.

ELEMENTS OF ENGLISH SPEECH. By ISAAC BASSETT CHOATE. New York: D. Appleton & Co. Pp. 220. Price, $1.

PERHAPS this book may be briefly described as a volume of essays on topics in the English language. The first four chapters are devoted to demonstratives, prepositions, connectives, and nouns, dealing with the functions of these parts of speech, and giving the histories of many words, with illustrative quotations from early English poems. The next four chapters deal with verbs and their conjugation. Certain causes of changes in pronunciation of the Latin and English languages are next considered, and the original meanings of some familiar words are shown.

T. LUCRETI CARI DE RERUM NATURA (T. Lucretius Carus concerning the Nature of Things). With an Introduction and Notes. By FRANCIS W. KELSEY. Boston: John Allyn. Pp. 385. Price, $1.75.

THE entire poem of Lucretius is here published, in Latin, with explanatory notes on the first, third, and fifth books, which are chosen for comment because they contain the gist of the poet's doctrine and a greater number of fine passages than the others. An analysis of the subject-matter given in the introduction will facilitate the reading of the remaining books. Besides the notes and the analysis, the editor gives essays in the introduction on "Lucretius as a Man," "Lucretius as a Philosopher," and "Lucretius as a Poet." The second essay includes reviews of philosophy among the Romans in the poet's time, and of epicureanism up to his time, and as set forth by him.

COUNTRY COUSINS: Short Studies in the Natural History of the United States. By ERNEST INGERSOLL. New York: Harper & Brothers. Pp. 252.

MANY animal families are represented in these sketches of "Country Cousins"; the squirrel, shrew, elk, and a number of our birds are visited in their homes, and there is an account of "rattlesnakes in fact and fancy." A description is given of Professor Agassiz's sea-side laboratory on Penikese Island, which furnishes an introduction to several chapters on sea-creatures, including the life and tribulations of the oyster, and sketches of other mollusks, devil-fishes, and seals. There are also accounts of the caverns at Luray and at Pike's Peak, a chapter on the shell-money of the native Americans, and one on village naturalists' clubs. The volume is handsomely illustrated.

LAND AND ITS RENT. By FRANCIS A. WALKER, Ph. D., LL. D. Boston: Little, Brown & Co. Pp. 232. Price, 75 cents.

THIS volume contains the substance of four lectures delivered in Harvard University, in May, 1883. While the author differs from most American economists upon the relation of wages to the interest of capital and to the profits of business management, he claims to be, in his view of the origin of rent and its influence upon the distribution of wealth, "a Ricardian of the Ricardians." He first presents the economic doctrine of rent, and then considers attacks upon the doctrine by Bastiat, Carey, and Leroy-Beaulieu. He expresses a high opinion of Bastiat's noble purpose and able writing, but says that, "as a constructive economist, he made a dead failure, while his views regarding the land are especially erroneous." Attacks upon the practice of individual appropriation of land, by J. S. Mill and Henry George, are next examined, and the propositions of the latter are emphatically condemned. In the concluding chapter Dr. Walker offers some suggestions regarding that tenure of the land which is best suited to advance the interests of society as a whole.

PUBLIC RELIEF AND PRIVATE CHARITY. "Questions of the Day," No. 13. By JOSEPHINE S. LOWELL. New York: G. P. Putnam's Sons. Pp. 111. Price, paper, 40 cents.

STARTING with the conviction that it is for the best interests of all that the indigent members of any civilized community be kept from desperation or death by the produce of those who work, the writer goes on to show that care within the walls of institutions is much more economical, and has a better moral effect, than out-door relief. Copious extracts from reports and addresses, testifying to the evil results of out-door relief practice in England, are given, and are supplemented by similar testimony from Continental and American observers. For each county three departments are recommended, namely: for the care of children, care of public dependents, and reduction of crime. Special attention is directed to the importance of removing children from the influence of vicious parents, and the labor-test as a preliminary to aiding able-bodied adults is insisted on.

THE HUMAN BODY. By H. NEWELL MARTIN and HETTY CARY MARTIN. New York: Henry Holt & Co. Pp. 261, with Plates. Price, 90 cents.

THIS is a "beginner's text-book" in anatomy, physiology, and hygiene. It attempts to present accurately, and, at the same time, in such a way that children can understand them, those facts concerning the structure and actions of the living human body which it is desirable, for practical purposes, that every one should know. The broad facts of human anatomy and physiology are presented, but little more is introduced than is necessary to make clear the reasons, as regards the preservation of health, for following or avoiding certain courses of conduct. Prominence is given to matters which are usually within the easy control of each individual. The dangers attending the use of stimulants and narcotics are forcibly presented.

BERMUDA: AN IDYL OF THE SUMMER ISLANDS. By JULIA C. R. DORR. New York: Charles Scribner's Sons. Pp. 148, with Maps. Price, $1.25.

THE author spent a spring in Bermuda, and in this book records her experiences and observations in a pleasant and instructive manner. She gives personal adventure, geography, history, pictures of life and descriptions of scenery, character-sketches, and a little natural history, gossip, and useful information, judiciously proportioned and pleasantly mingled. These qualities make the work as good a guide as the visitor would wish to carry with him, or, if he does not wish to go, a most agreeable companion for his "fireside travel"—the imaginary journey he might take while sitting before his fireplace.

VOCAL AND ACTION LANGUAGE. By E. N. KIRBY. Boston: Lee & Shepard. Pp. 163. Price, $1.25.

MR. KIRBY'S hand-book has grown up in the class-room, and is designed to supplement, not to supplant, the work of the teacher. He insists on physical training as one of the fundamentals of vocal culture, and gives descriptions of the respiratory and vocal organs, based upon Dr. Martin's "The Human Body," with cuts from that work. Vocal development, orthoepy, and

vocal expression, are considered successively, and then follows expression by action, not only by the arms, but also by the head, trunk, and legs. Some general directions for public speaking, and several selections, with the elocutionary analysis marked, are added.

PUBLICATIONS RECEIVED.

A Directory of Writers for the Literary Press in the United States. Compiled by W. M. Griswold, A. B. Bangor, Me.: Q. P. Index, publisher. 1884. Pp. 25. 50 cents.

"United States Publications. Monthly Catalogue." Vol. I, No. 1. January, 1885. J. H. Hickcox. Washington, D. C. Pp. 22. $2 a year.

Proceedings of the American Society of Microscopists. Seventh Annual Meeting. Buffalo: Bigelow Brothers, printers. 1884. Pp. 300.

Mind in Medicine. By Rev. Cyrus A. Bartol, New York: M. L. Holbrook, publisher. 1884.

Moeris. The Wonder of the World. By F. Cope Whitehouse, M. A. New York: John Wiley & Sons. 1885. Pp. 16. Illustrated.

"Bulletin of the New England Meteorological Society." Nos. 1 and 2. November and December, 1884.

Obstructions of the Gall-Duct, with Remedial Operation suggested. By J. McF. Gaston, M. D. Pp. 27.

"Journal of Mycology." W. A. Kellerman, Ph. D., Editor. Manhattan, Kansas. Vol. I, No. 1. January, 1885. Monthly. Pp. 16. $1 a year.

Notes on the Progress of Mineralogy in 1884. By H. Carvill Lewis. Philadelphia. January, 1885.

Sunlight. Short Letters to the Editor of the Belfast "Northern Whig." By the author of "The Beginnings." Pp. 66.

Circulars of Information of the Bureau of Education. No. 6, 1884. Rural Schools. Washington: Government Printing-Office. 1884. Pp. 90.

Conspectus of the Medical Colleges of America. Sessions of 1884-'85. Illinois State Board of Health. Springfield, Ill. 1884. Pp. 96.

The Composition and Methods of Analysis of Human Milk. By Professor Albert R. Leeds, Ph. D. Pp. 27.

Quarterly Report of the Chief of the Bureau of Statistics for the Three Months ending September 30, 1884. Washington: Government Printing-Office. 1885. Pp. 249.

The Genesis of the Merrimack Valley. By Samuel D. Lord. Concord, N. H. 1885. Pp. 17.

The Fucoids of the Cincinnati Group. By Joseph F. James. Reprint from the "Journal of the Cincinnati Society of Natural History" for October, 1884, and January, 1885. Pp. 25. Illustrated.

"Journal of the New York Microscopical Society." Edited by Benjamin Braman. Vol. I, No. 1. January, 1885. New York. Pp. 32. Nine numbers to the year; subscription price, $1.

The Next Step of Progress: A Limitation of Wealth. By John H. Keyser. Pp. 50. Price 20 cents.

Notes on the Condition of Zoölogy Fifty Years ago and To-day. By Professor E. S. Morse. Salem, Mass. 1884. Pp. 9.

"The West-American Scientist." C. R. Orcutt, San Diego, Cal. Vol. I, No. 2. January, 1885. Monthly. Pp. 8. 50 cents a year.

Christianity a Reward for Crime. By O. B. Whitford, M. D. New York: The Truth-Seeker Company. 1885. Pp. 29.

Man in the Tertiaries. By Edward D. Cope. 1884. Pp. 15.

Report of the Executive Committee of the Niagara Falls Association. January, 1885. Pp. 43.

The Part of Jesus and of the Apostles. By Dr. G. M. Rabbinowicz. Translated from the French by Philip Zadig. San Francisco, Cal.: J. B. Golly & Co. 1884. Pp. 218.

Studies from the Biological Laboratory of Johns Hopkins University. Edited by H. Newell Martin and W. K. Brooks. Vol. III, No. 2. December, 1884. Baltimore: N. Murray. Pp. 70. 50 cents.

Fourth Annual Report of the Astronomer in charge of the Horological and Thermometric Bureaus of the Observatory of Yale College. 1883 and 1884. By Leonard Waldo. Pp. 13. And Report for the year 1883-'84 of the Board of Managers of the Observatory of Yale College. Pp. 19.

Maryland's Influence upon Land Cessions to the United States. By Herbert B. Adams. Part I; Third Series Johns Hopkins University Studies in Historical and Political Science. Baltimore, January, 1885. Pp. 101. 75 cents.

Heavy Ordnance for National Defense. By Lieutenant William H. Jaques. New York: G. P. Putnam's Sons. 1885. 25 cents.

Comparative Study of German. By William W. Valentine. Richmond, Va.

Annual Report of the Hydrographer to the Bureau of Navigation for the Year ending June 30, 1884. Washington: Government Printing-Office. 1884. Pp. 19.

Reports of Observations and Experiments in the Division of Entomology, United States Department of Agriculture. By C. V. Riley, Entomologist. Washington: Government Printing-Office. 1884. Pp. 102.

Steam-Boilers as Magazines of Explosive Energy. By Professor R. H. Thurston. 1884. Pp. 26.

Description of Carcharodon Carcharias. By W. G. Stephenson, M. D. Poughkeepsie, N. Y. 1884. Pp. 8. Illustrated.

On the Iron-Ores of the Juragua Hills, Santiago, Cuba. By James P. Kimball. 1884. Pp. 36, with Maps.

Note on a Peculiar Form of Pulmonary Congestion. By A. H. P. Leuf, M. D. 1885. Pp. 15.

Report on the Industrial, Social, and Economic Conditions of Pullman, Ill. By the Commissioners of the State Bureau of Labor Statistics. 1884. Pp. 27.

The Pororóca. By John C. Branner, B. S. Boston: Printed by Rand, Avery & Co. 1885. Pp. 12.

Notes on the Psychology of the Chimpanzee. By Dr. C. Pitfield Mitchell. 1885. Pp. 16.

The Distribution of Products. By Edward Atkinson. New York: G. P. Putnam's Sons. 1885. Pp. 300. $1.25.

Stories by American Authors. New York: Charles Scribner's Sons. 1885. Pp. 180. 50 cents.

A Popular Exposition of Electricity. By Rev. Martin S. Brennan. New York: D. Appleton & Co. 1885. Pp. 191. 75 cents.

The Wane of an Ideal. A Novel. By La Marchesa Colombi. From the Italian by Clara Bell. New York: W. S. Gottsberger. 1885. Pp. 260. 90 cents.

Shadows. By John Wetherbee. Boston: Colby & Rich. 1885. Pp. 287.

Geonomy. By J. Stanley Grimes. Philadelphia: J. B. Lippincott & Co. 1885. Pp. 116.

Egypt and Babylon. By George Rawlinson, M. A. New York: Charles Scribner's Sons. 1885. Pp. 329. $1.50.

One Hundred Years of Publishing—1785-1885. Philadelphia: Lea Brothers & Co. 1885. Pp. 20.

Annual Report of the Chief Signal Officer to the Secretary of War for the Year 1883. Washington: Government Printing-Office. 1884. Pp. 1,164.

Sixth Annual Report of the Illinois State Board of Health. Springfield, Ill. 1884. Pp. 324.

Memoir upon the Formation of a Deaf Variety of the Human Race. By Alexander Graham Bell. Pp. 86.

Researches on Solar Heat and its Absorption by the Earth's Atmosphere. A Report of the Mount Whitney Expedition. By S. P. Langley. Washington: Government Printing-Office. 1884. Pp. 242.

The Story-Hour. For Children and Youth. By Susan H. Wixon. New York: The Truth-Seeker Company. 1885. Pp. 222. Illustrated.

POPULAR MISCELLANY.

Electric Lighting in America.—At the meeting of the Society of Arts on December 3d, Mr. W. H. Preece read a paper in which he stated that electric lighting is flourishing in America much more than in England. There are probably ninety thousand arc-lamps alight every night in the United States. He had found it a dismal experience to be transferred from the brilliantly illuminated avenues of New York to the dark streets of London. On the evening of October 21st he drove from the Windsor Hotel, New York, to the Cunard wharf, a distance of about four miles, through streets entirely lighted by electricity. On arriving in London, he drove from Euston to Waterloo without seeing a single electric light. In Montreal, Philadelphia, Buffalo, Cleveland, Chicago, St. Louis, Indianapolis, and Boston, he found the principal streets and warehouses, as well as stores and places of public resort, lighted by arc-lamps. Police supervision of the streets is rendered far simpler when they are brilliantly illuminated by the electric light. It is with arc-lighting that the greatest advances have been made in the States. In Chicago the number of arc-lamps installed has doubled during the past twelve months; it is now two thousand, and increases daily. More than one electric light company pays dividends to its shareholders, and all of the manufacturers of supplies are busy. The great ferry-boats of the Pennsylvania Railroad are lighted by electricity; those magnificent hotel-steamers that ply between New York and Fall River, those on Lake Superior, on the Mississippi and other large rivers, are either so lighted or are gradually being fitted for the lamps. Mr. Preece said that electric wires carried overhead, in the unsightly fashion which prevailed in the United States, were hideous in the extreme, and the only advantage he had found for them was that they afforded a welcome shade from the fierce glare of the sun. He had counted 144 wires on one post in New York, and six lines of posts might be found on Broadway, there being thirty-two companies in the city carrying wires on poles. There was no necessity for it at all, for it was found by the English Post-Office that, whenever the number of wires through a town exceeded fifteen, it was cheaper to put them underground than overhead.

The Oldest Land-Animal.—Mr. Lindstrom, of Stockholm, has described a fossil scorpion which has recently been found in the Upper Silurian strata of the Island of Gottland, Sweden. According to photographs forwarded to the French Academy of Sciences, the specimen is fairly well preserved, with the chitinous cuticle still visible. The cephalothorax can be distinguished, together with the abdomen with seven dorsal laminæ, and the tail of six segments, the last of which is contracted into a point and forms the poisonous sting. The superficial structure of the animal is quite similar, with its tubercles and longitudinal keels, to that of recent scorpions. One of the stigmata is visible on the right, to indicate that the animal was an air-breather, and the whole organization shows that it lived on the land. Mr. Lindstrom regards this as the oldest land-living animal yet discovered, the fossil dragon-flies of Canada having been found in the Devonian. It is remarked of this animal that the large and pointed character of the four thoracic paws is characteristic of the embryos of several other *Tracheata*, and had disappeared from fully-developed scorpions as early as the Carboniferous period. A similar fossil scorpion has just been found in the Upper Silurian of Scotland.

Parasites in Domestic Fowls.—On dissecting a fowl which had died from sickness, Thomas Taylor, M. D., of the Department of Agriculture, found reddish markings on the rib-muscles and the lungs, which under the microscope were seen to consist of numerous mites, closely resembling *Cytoleichus sarcoptoides* (Mégnin), a species not hitherto reported in America. When the skin was

removed from another fowl, great numbers of small, white, opaque specks were seen in the cellular tissue, and by means of the microscope mites were found, of the species *Laminosioptes gallinorum* (Mégnin). The opaque specks were of a calcareous substance, and many contained the remains of one or more of these mites. In the same fowl Dr. Taylor found thousands of encysted nematoids, resembling, under a microscope of low power, *Trichina spiralis*, but under a power of about 500 diameters they seemed to be of an undescribed species. A third fowl also contained mites of the species *gallinorum*. Dr. Taylor deems it probable that a considerable amount of disease prevailing among American domestic fowls, and not referable to any known type, may be due to such parasites. He suggests that carbolic acid, or other disinfectants, sprinkled about henneries, might prove useful as an antidote to these, and to external parasites.

The Ferment-Organism in Plant-Growth.—Professor Storer, of the Bussey Institution, in reporting upon his experiments with vegetable mold as a fertilizer, suggests that the activity of the development of the organism or ferment of nitrification is a very important factor in the action of manures, which deserves careful study. Indeed, he says, one of the first things now to be done in seeking to explain the agricultural value of the nitrogen in vegetable mold is to determine precisely what the ferment-organism is, and to study its habits and the history of its development. When this knowledge has been gained, "it will doubtless be practicable for the farmer to employ the soil-nitrogen in a much more intelligent way than has been customary hitherto. He will then be able to count definitely upon the soil-nitrogen as a resource in a sense that was hardly to be thought of by his predecessors. Many methods of tillage and of manuring, and some modes of mulching—the conduct of which is now purely empirical—and the whole subject of composts made with peat and loam, will undoubtedly then be brought into the domain of reasonable practice. For example, the question is now open whether the power of clover and root-crops to supply themselves with nitrogen may not depend upon the comfort and shelter these crops offer to the nitrifying ferment. It is not unlikely that the ferment-organism may prosper exceedingly beneath the dense shade of clover and other large-leaved plants, in the comparatively moist surface-soil which is peculiar to such fields. Perhaps even the manner in which the roots of those plants act upon the soil may have a favorable influence upon the life of the ferment. . . . So, too, in the case of Indian corn, a plant which grows vigorously in hot weather, it is probable that its observed power of utilizing the soil-nitrogen to better advantage than the small grains can will be found in some peculiarity of the crop which promotes the growth of the nitric ferment in the soil beneath it, and so makes the nitrogen of the vegetable mold available as plant-food." On this point, Jared Eliot, writing in 1747 on the importance of tilling Indian corn thoroughly, observed: "What is still more remarkable, if the Indian corn be well tilled, the next crop, whether it be oats or flax, so much the bigger and better will that succeeding crop be, so that the land must have gained strength and riches; if it were not so, why did not the Indian corn exhaust and spend the strength of the land, especially when we consider how large corn is made to grow by the good tillage?" Professor Storer predicts that the making of composts may, if his hypothesis is true, soon cease to be regarded as a subject of technical chemistry, and the consideration of the theory of composting may pass from the chemist's hands into those of the botanist or biologist.

Importance of cultivating the Eye-sight.—Dr. R. Brudenell Carter has published a paper urging that the culture and improvement of the eye-sight should receive a share of the attention that is given to physical development in other directions. He believes that it is not school-life alone, but the general conditions of civilization that have diminished our capacity of vision, and cites instances of sharp sight and long sight in savages, that were not regarded as at all unusual, where white men were exceedingly dull of vision. "Is there any reason," he asks, "why perfection of sight should not

be made a point of physical excellence in all athletic contests? The example might be fitly set by the volunteers, who might thereafter in time diminish the diameter of the bull's-eyes of their targets; and it would soon be followed by common schools and by athletic clubs. The tests would be easy of application, the value and uses of superiority would be unquestionable. A first effect would be to make people understand what they ought to be able to see, and a counteracting influence would be brought to bear against those conditions which at present render it difficult for the dwellers in large towns ever to look at a distant object. Important good results would not be immediate, nor could they be fully attained except in more than one generation; but I think it can not be doubted that they would ultimately follow. . . . The games which require close attention to a flying object, such as tennis, battledoor and shuttlecock, and in a less degree cricket, are among the most powerful agencies by which the muscles in question can be strengthened and improved."

Industrial Uses of Mica.—Mica has the invaluable properties of being proof against the attacks of every acid, totally incombustible, and impervious to the action of air and water, and of being indefinitely divisible into thinner and thinner plates. In consequence of these properties it is applicable to a great variety of purposes, and much attention has recently been given to its industrial use. Its manufacture into various articles has been carried on at Max Raphael's establishment in Breslau, Germany, for nineteen years, and has been constantly marked by improvements and new applications introduced from time to time. Its transparency makes it highly available for the glazing of microscopic preparations and the preservation of plant specimens. In England it is employed in the windows of machine-shops, where glass is liable to be broken by splinters of metal. More recently it has been employed in the membranes of phonographs and the diaphragms of telephones. Tablets of it are frequently inserted in the doors or walls of smelting-furnaces, to permit a view of what is going on inside without exposure of the eye. The dials of compasses and the window-lights of war-ships have been made of mica, to avoid the shattering of glass by the cannon-shots of hostile vessels. The mineral has been found extremely valuable for incombustible lamp-shades and screens. Being a poor conductor of heat, mica has been applied with great advantage to use in screens to be placed before open fires, by the aid of which the heat is more evenly distributed through the room without any part of it being subjected to an extreme exposure, while the cheerful light of the fire can be enjoyed at the same time without inconvenience. One of the most valuable applications of mica has been found in the making of spectacle-glasses from it, to be worn by workmen in foundries, machine-shops, and other places where hot metal has to be handled, or where the eyes are exposed to the intense glow of the furnaces. Mica in small scales or coarse powder is worked up into a mica brocade or pearl-glazing, for the decoration of articles of fancy. These goods are made in silver and other colors in considerable quantities, at shops in several German towns. The silver brocade is the natural white mica, pounded up, treated with hydrochloric acid, washed, dried, and assorted into grades of fineness by passing it through sieves. The colored varieties are dyed with aniline colors. The mica is applied to the articles it is intended to ornament by sprinkling it upon them, after they have been covered with gum, or a sticky earth, and then varnished, when very fine effects may be produced. The mica brocade is now preferred to the brocades formerly made with bronze, because it is not affected by the sulphureted hydrogen in the atmosphere, by which the latter always, sooner or later, becomes tarnished.

Forbidden Numbers.—Dr. Goldziher, an eminent student of Semitic lore, remarks upon the peculiar dread that some Mohammedan communities exhibit in respect to particular numbers. In Morocco, five is an object of terror, and it is not permissible, says Höft, to speak of five in the presence of the king; but we must always say four and one, fourteen and one, twenty-four and one, etc. The superstition may have originated in the fact that the hand, which may be

laid upon the king, or which is raised to forefend the evil-eye, and which is supposed in Northern Africa to have great magic power, has five fingers. According to the traveler, Ibn Batûta, the people at Sarmin, near Aleppo, will not speak of ten, but always of nine and one, and a mosque at that place has only nine cupolas. The Shiites in India take the greatest pains to avoid the number four, some of them going so far as to use six-legged instead of four-legged bedsteads; and if one of them inadvertently pronounces the number he will immediately clear his throat as if to spit it out.

The Oldest Geographical Society.—The Paris Geographical Society, the oldest existing society of that kind, was founded on the 15th of December, 1821, when 217 persons recorded themselves as members. Among these original members were men of great eminence in their respective fields of science. Of them, M. Vivien de St. Martin is the only survivor. The "Bulletin" of the society has been issued regularly since its institution, and the series now forms in itself a library of 120 volumes. It has published several volumes of accounts of travel, many of them of great value, and has awarded 150 prizes for geographical research. Its library includes more than 25,000 volumes and pamphlets, 3,000 maps, and 600 portraits of famous geographers and travelers. Most of the learned professions and departments of public service, and nearly all important nations, are represented in its list of members, in which also seven royal personages —among them King Norodom I, of Cambodia, and Sultan Syied Barghash, of Zanzibar—have had themselves enrolled. Since the Franco-German War, the society has paid particular attention to the study of geographical questions bearing on trade, to the exploration of newly-opened regions, and to the popularization of geographical knowledge.

Tastes for Strange Meats.—The fact, which is made evident by the condition of the remains, that the cave-men on occasion ate wolves, foxes, and similar animals, has been supposed to show that they were often reduced to great misery; but observations among living men prove that there are tastes in such matters that are often as potent as want. Some of the tribes of Alaska are capable of eating with relish things that it is disgusting even to mention in that connection. There are tribes in Kamchatka, Siberia, and Mongolia, according to travelers in those regions, that are fond of the flesh of wolves, foxes, and badgers, and some believe that it brings them luck in hunting. The Moquis Indians are said to esteem wolf's meat; and the Earl of Southesk, in the Saskatchewan, said that the flesh of the large wolf was "very good eating," that of the small one uneatable. Heusser tells of Indians in Brazil who find the meat of two species of this family much to their taste. Chapman says that jackal-meat is considered a great delicacy by the Balalas of South Africa, and that they were surprised to learn that the English did not like it. The striped hyena is believed to confer magic powers, and his flesh, hair, and teeth are objects of contention. According to Schweinfurth, the people of Charzeh, of Berber descent, eat all game, including hyenas. According to Livingstone, while the Maqua reject the flesh of hyenas and leopards, their neighbors, the Manganja, on Lake Nyassa, regard the flesh of the animals that "make discords in the chorus of the spheres" at night as delicious viands.

An Ascetic Indian Tribe.—Sir J. H. Lefroy speaks of the narrative reports of the officers of the Indian Survey as being full of ethnographic and other curious information. Take, for example, the account given by Mr. G. A. McGill, in 1882, of the Bishnoies of Rajpootana, a class of people who live by themselves, and are seldom to be found in the same village with the other castes: "These people hold sacred everything animate and inanimate, carrying this belief so far that they never even cut down a green tree; they also do all in their power to prevent others from doing the same, and this is why they live apart from other people, so as not to witness the taking of life. The Bishnoies, unlike the rest of the inhabitants, strictly avoid drink, smoking, and eating opium, this being prohibited to them by their religion. They are also strictly enjoined to monogamy and to the performance of regular ablutions daily. Under all these

circumstances, and as may be expected, the Bishnoies are a well-to-do community, but are abhorred by the other people, especially as by their domestic and frugal habits they soon get rich, and are the owners of the best lands in the country."

Wild Birds in Cities.—About fifty-five species of wild birds make themselves at home in the city of Paris and find their living there. All of the orders, except perhaps the climbers, are represented among them. One bird of prey, a pelerine falcon, established himself on the towers of Notre Dame a few years ago, whence he hunted the pigeons of the quarter, and a fisher-martin, leaving the marshes he was accustomed to frequent, when the water became too low for him, came to hunt insects and little fishes in the midst of the city, near the Pont des Arts. A number of woodcocks and rails, a season or two ago, haunted the ponds of la Glacière, and a few pairs of water-fowl made their nests in the same place. But these wading birds will probably soon have to seek another abode, for their domains are being reduced every day, and there will shortly be no trace left of the old marsh. A brace of quails are installed in the same region, whose presence is revealed every June by the well-known call of the male. The pigeons form, during the pleasant season, numerous colonies in the public gardens, where also establish themselves numbers of woodpeckers, linnets, red-tails, blackbirds, greenfinches, chaffinches, sparrows, and rooks; while swallows, martins, and jackdaws build their nests under the cornices of the houses or conceal them in chimneys, in the holes of old walls, and in church-towers. No species live on terms of closer intimacy with the human inhabitants than the sparrows, which everywhere seek the neighborhood of man. No bird has been more calumniated; but, admitting that they have mischievous traits, it is certain that they are most active and efficient destroyers of noxious insects. The English ornithologist Macgillivray asserts that without them the kitchen-gardens around London would not be able to furnish the market with cabbages; and M. Châtel, of Vire, regards them as the most useful of insectivorous birds. They are noisy and pugnacious, and seem better suited with city than with country life. They have multiplied wonderfully in all the European and in the American cities. M. Nérée Quépat, author of the "Ornithologie Parisienne," believes that there are three times as many sparrows in Paris as there are of human inhabitants, and, in view of the innumerable flocks of them to be seen in all parts of the city, it is easy to credit the assertion. The pigeons also are nearly as well domesticated as the sparrows, but are less constant in their attachment to their home, for they leave the city in the fall, to winter in a southern climate. They are exposed to capture and destruction during their journey by the people of Southern France, and their numbers are diminishing; so that, unless precautions are taken to save them from this persecution, Paris will in time know them no more.

Spider-Threads for Economical Uses.—We have already mentioned some of the efforts that have been made to spin threads and weave cloths of spiders' webs. They have so far fallen short of success, on account of the difficulty of getting enough of the fiber, and of the lack of strength of most spiders' threads. A few species of spiders encourage the hope that the manufacture of spider-cloth may yet become something more than a dream. Sir Samuel Baker describes a spider in Ceylon, two inches long, that spins a beautiful yellow web two feet and a half in diameter, so strong that a walking-stick when thrown into it is entangled and retained among the meshes. Mr. F. W. Burbridge, in "The Gardens of the Sun," describes a larger spider which spins a web strained on lines as stout as fine sewing-cotton. Dr. Walsh tells from personal observation of a still larger spider, the *Aranea maculata* of Brazil, whose web, ten or twelve feet in diameter, very sensibly entangled his head and forced him to leave his hat behind when he came out from it. Lieutenant Herndon, of the United States Navy, confirms this account, and estimates the diameter of a web he saw at ten yards. The furnishing of cross-lines for telescope-glasses can hardly be the only use to which these beautiful threads are adapted.

Testing Lighthouse-Lights. — Experiments have been begun by the corporation of Trinity House, at the South Foreland, England, to determine the relative value of the electric, gas, and oil lights as illuminants for lighthouses. The two lighthouses already established on the Foreland are illuminated by electricity, and are known as the high light and the low light. Near them have been erected three experimental lighthouses: one, provided with electrical lights that have a total power of 30,000 candles; a second, furnished with gas-burners, of Mr. Wigham's design, that may give a total of 12,000 candles; and the third, with the oil and gas burners invented by Sir James Douglass. Three stations have been fixed for testing the lights, at distances respectively of half a mile, a mile and a quarter, and two and a half miles, at which huts have been fitted up as photometric observatories. Measurements will be taken for determining the penetrative power of the several illuminants in different states of the weather, and for ascertaining to what extent the principle of superposition of lights may be applied. One of the questions to be determined is relative to the comparative value of a large area of low illumination and a small area of high illumination.

New Pests in exchange for Old. — The Australasian colonies have suffered greatly from the multiplication of rabbits, which were originally introduced there from England. Now, they are crying out against a plague of dogs, which, increasing rapidly, and semi-wild, have become very destructive to the sheep, and rewards are offered for their destruction. It is proposed to import stoats and weasels into New Zealand to put down the rabbits; but, if this is done, there is danger that the latter estate of the colony will be worse than the present one. The sugar-planters of Jamaica have suffered greatly from the depredations of rats among their canes, and mongooses have been imported to destroy them, with apparent general benefit so far. "But the new importation continues to multiply and spread, not only on sugar-estates, but on the highest mountains, as well as along shore, even amid swamps and lagoons; and, when the sugar-cane rat is wholly exterminated, the mongoose will still go on increasing, and what then? Must the colonists find something else to exterminate the mongoose, and save their poultry, and so on *ad infinitum*?" As it is, many of the harmless indigenous fauna of the island are already diminishing under its attacks.

NOTES.

Dr. B. A. Gould, of the observatory at Cordoba, Argentine Republic, writes to Professor J. D. Dana that, after fourteen years of absence from his country, he finds himself so near the end of the special work on which he has been engaged that he hopes to revisit New England in the spring. Four volumes of star positions have been published, and a meteorological volume is started on its way. He hopes to leave a mass of similar material for the occupation of his successors in the institutions; to leave the manuscript of seven astronomical quartos ready for the press; and to bring with him for publication in the northern hemisphere the "General Catalogue of Southern Stars," which will complete the astronomical work.

Mr. W. E. Garforth, of Normanton, England, has invented a simple apparatus for detecting fire-damp in collieries. It consists of a small India-rubber hand-ball fitted with a protected tube. By compressing the ball and then allowing it to expand in a suspected atmosphere, it becomes filled with the air. It can then be taken to a safe place, and the air can be tested in a lamp.

Success is claimed to have attended the operation of the system of jetties planted by Captain Eads for deepening the channel of the Mississippi River near its mouth. While there were formerly only from eight to thirteen feet of water over the bars at low water, the least depth through the jetties was, last May, thirty-three feet, and the channel is steadily wearing itself deeper.

At the recent meeting of the German naturalists and physicians at Magdeburg, Professor Landois, of Münster, spoke of the imperfections and comparative uselessness of most zoölogical gardens, and advised the institution of smaller gardens having well-defined fields of observation and investigation. He cited the successful example of the zoölogical section of Westphalia and Lippe, whose garden of native beasts yielded an annual surplus. In connection with this is established a zoölogical museum of the district, in which the biological side is kept prominent, and which is nearly complete in invertebrates. The section publishes scientific lists of the native fauna, and is preparing for a wider circulation a "Westphalian

Animal Life in Word and Picture," which is to be published in elegant style, and of which the first volume, the "Mammalia," is ready.

DR. A. N. RANDOLPH has made experiments on the behavior of the mixture of hydrocarbons called *petrolatum*, or, commonly, vaseline, in the digestive tract, by which he has learned that it passes from the system wholly unchanged. It is, therefore, valueless as a food-stuff, while it is at the same time entirely unirritating to the digestive tract.

MR. A. V. ADRIANOF has contributed to the Russian Geographical Society an account of a people living in the basin of the river Kemtsik, called the Sayanians, or Sayantsi, who display a remarkable capacity for mixing with neighboring races without being merged. Many of their burying-places are of considerable antiquity, and are either marked by conical cairns or are flat areas surrounded by a circular row of stones. The stones are sometimes plain, but often covered with inscriptions, and bear in some instances rude representations of the human figure. In the immediate neighborhood of the tombs may be observed the remains of the sacrifice, the victim usually being a horse. Similar sacrifices are still offered, at which the flesh of the slaughtered horse is eaten, and the head and skin are raised on a pole.

A PAPER by Mr. F. Cope Whitehouse, stating his reasons for believing Fingal's Cave in the Island of Staffa to be of artificial construction, accompanied by photographs illustrating his views, was presented to the French Academy of Sciences at its meeting of December 1st, by M. Daubrey, the geologist.

M. EUGÈNE FOUCAULT, a French antiquary, has found in Brittany a bronze axe, with the handle attached—the first specimen of the kind known to have been found in France, and probably in the world. The tool is furnished with a cutting edge on one end, and a kind of hammer-cap on the other.

PROFESSOR LANDOIS, of Münster, reported to the recent scientific assembly in Germany on his examinations of the viscera of Westphalian woodpeckers, for the estimation of the economical influence of the birds. They showed that those particular woodpeckers at least were decidedly useful and beneficial. Their food consists, summer and winter, of both animal and vegetable matter, but the latter is mostly the seeds of coniferous plants. The abundance of aphides and larvæ of diptera found in the entrails showed that the birds made a very extensive slaughter of minute insects. The simple percussion on the bark of the trees does no harm, and their nesting is rather beneficial than otherwise, for it anticipates the destructive life that would otherwise be hatched in the hollows.

OBITUARY NOTES.

PROFESSOR BENJAMIN SILLIMAN, of Yale College, died in New Haven, January 14th, of dropsy induced by heart-disease, after having been ill since the 6th of October. He was in the sixty-ninth year of his age. He had been connected with Yale College as a teacher or professor since he graduated in 1837. He had been identified with the Yale (or Sheffield) Scientific School, which he organized, from its beginning. He was one of the Trustees of the Peabody Museum of Natural History, and was a member of numerous scientific societies on both sides of the Atlantic. A portrait and sketch of Professor Silliman were published in "The Popular Science Monthly" for February, 1880.

MR. ALFRED TYLOR, F. G. S., of Carshalton, England, a business man, who also found time to contribute to the advancement of science, died December 31st, more than sixty years old. He was a brother of E. B. Tylor, the anthropologist, and had been the friend and the companion, in some of his earlier geological excursions, of the late Professor Edward Forbes. He was interested in questions of physical geology, including the formation of valleys, the erosive action of rivers, and the origin of gravels and other superficial deposits, on which subjects he was a frequent writer. He was also interested in questions of archæology and anthropology, and had enjoyed the pleasure of discovering some remarkable Roman remains on his own premises.

MR. JAMES NAPIER, of Glasgow, who has been long identified with chemistry and the manufacturing arts, especially with electro-metallurgy, died, near the close of last year, at about seventy-four years of age. He was the author of "Ancient Workers in Metal," "The Manufacturing Arts in Ancient Times," "Old Ballad Folk-Lore," and of many memoirs in the "Proceedings" of the Philosophical Society of Glasgow.

M. JULES BERTIN, a French forest-inspector, and author of several books on forestry, died in December last, at Boulogne.

MR. SEARLES V. WOOD, a British geologist, distinguished chiefly for his investigations of the newer Pliocene and glacial deposits of the eastern counties, died in December. He was author of several papers relating to his special subject in the Geological Society and the "Geological Magazine."

THE death was announced, early in January, of M. Victor Dessaignes, a French chemist, who was distinguished for his delicate researches in organic chemistry. He was eighty-five years old.